MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY (MIST)

SYLLABUS OF
BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING (BME)

March 2024

COMMITTEE FOR SYLLABUS REVIEW – BME DEPT, MIST

The undergraduate course curriculum of the Department of Biomedical Engineering (BME), Military Institute of Science and Technology (MIST) has been reviewed by the committee as mentioned below and will be implemented from academic session 2024-2025 (Batch BME-10) and onwards.

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CHAPTER 1
GENERAL INFORMATION

1.1 Introduction to MIST

The necessity of establishing a technical institute for the Bangladesh Armed Forces was felt in the late eighties. In the absence of such an institution, officers of Bangladesh Armed Forces had been graduating from Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Technology (BIT) and other foreign institutions of science and technology. Intending to meet the increasing demand for the development and dissemination of engineering and technological knowledge, Bangladesh Armed Forces established the Military Institute of Science and Technology (MIST) that promises to provide facilities for higher technical education both for the officers of Bangladesh Armed Forces as well as for civil students from home and abroad. The motto of MIST is ―Technology for Advancement. Founded on 19 April 1998, MIST started its journey on 31 January 1999 by offering a four-year bachelor's degree in Civil Engineering. Bachelor degree in Computer Science Engineering course started in 2001. Bachelor courses in Electrical, Electronic & Communication Engineering and Mechanical Engineering started its journey from 2003. Bachelor of Science program on Aeronautical Engineering (AE) and Naval Architecture and Marine Engineering (NAME) program were started from 2008-2009 and 2012-2013 respectively. Besides, four new departments started their academic session from 2014-2015, i.e. Nuclear Science & Engineering (NSE), Biomedical Engineering (BME), Architecture (Arch) and Environmental, Water Resources & Coastal Engineering (EWCE).

1.2 Vision and Mission of MIST

Vision: To be a centre of excellence for providing advanced quality education in the field of science, engineering, and technology advanced to create diverse quality leaders and professionals and conduct innovative research to meet the national and global needs and challenges.

Mission: MIST is working on the following missions:

a. To develop as a Centre of Excellence for providing comprehensive education and conducting creative and innovative research in diverse disciplines of engineering, technology, science, management and related fields.

b. To produce technologically advanced intellectual leaders and professionals with high moral and ethical values to meet the national and global needs for sustainable socio-economic development.

c. To provide consultancy, advisory and testing services to government, industrial, educational and other organizations to render technical support for widening practical knowledge and to contribute to sustainable socio-economic advancement.

d. To extend collaborative and research activities with national and international communities for life-long learning and long term interaction with the academician and industry.

1.3 Motto and Values of MIST

Motto: As an Institution without gender biasness, MIST is steadily upholding its motto "Technology for Advancement" and remains committed to contributing to the wider spectrum of national educational arena, play a significant role in the development of human resources and gradually pursuing its goal to grow into a 'Centre of 'Excellence'.

Values:

a. Integrity and Respect-We embrace honesty, inclusivity, and equity in all that we do.

b. Honesty and Accountability-Our actions reflect our values, and we are accountable for both.

c. Dedication to Quality and Intellectual Rigour-We strive for excellence with energy, commitment, and passion.

d. Pursuit of Innovation-We cultivate creativity, adaptability, and flexibility in our student, faculty, and staff.

1.4 Eligibility of Students for Admission in MIST

The students must fulfill the following requirements:

a. **Bangladeshi Students.** Minimum qualifications to take part in the admission test are as follows:

1) **SSC Examination (or Equivalent).** The applicant must have passed the examination in Science Group obtaining a minimum GPA of 4.00 (without fourth subject) on the scale of 5.0. Only the applicants who passed SSC or Equivalent Examination in Corresponding current and previous one year can apply.

2) **HSC Examination (or Equivalent).** The applicants passed in current and previous one year must obtain minimum total grade point 17 in four subjects (Mathematics, Physics, Chemistry and English).

3) **GCE ('O' and 'A' Levels or Equivalent)** who have passed HSC or equivalent examination in the current year or one year before the notification for admission can apply.

   a) The applicant who passed in current and previous one year must have qualified with minimum 'B' grade in five subjects including Mathematics, Physics, Chemistry, and English in GCE 'O' Level.

   b) The applicant who passed in current and previous one year must have minimum two 'B' grades and one 'C' grade in Mathematics, Physics, and Chemistry in GCE 'A' Level.

4) Applicants interested in Biomedical Engineering must have Biology at HSC or equivalent level with a minimum grade point of 'A-' / GCE 'A' or equivalent level with a minimum grade point of 'C'.

b. **Foreign Students.** Maximum 3% of overall vacancies available will be kept reserved for the foreign students and will be offered to foreign countries through AFD of the Government of the People's Republic of Bangladesh. Applicants must fulfill the following requirements:

1) Educational qualifications as applicable for Bangladeshi civil students or equivalent.

2) Must have security clearance from respective Embassy/High Commission in Bangladesh.

3) Sex: Male and Female.

**** In the event of non-availability of foreign students, Bangladeshi civil candidates will fill up the vacancies.***

1.5 Number of Seats

The highest number of seats for 04 (Four) years Bachelor Degree in Engineering programs (Unit – A) and 5 (Five) years Bachelor Degree of Architecture programs are as follows:

Allocation of Seats

Ser	Unit	Department	Seats
1	A	Civil Engineering (CE)	120
2		Computer Science and Engineering (CSE)	120

3		Electrical, Electronic & Communication Engineering (EECE)	120
4		Mechanical Engineering (ME)	120
5		Aeronautical Engineering (AE)	100
6		Naval Architecture and Marine Engineering (NAME)	40
7		Biomedical Engineering (BME)	40
8		Nuclear Science and Engineering (NSE)	40
9		Environmental, Water Resources and Coastal Engineering (EWCE)	60
10		Industrial and Production Engineering (IPE)	50
11		Petroleum and Mining Engineering (PME	25
12	**B**	Architecture (Arch)	25
		Total=	860

The total number is 860. In general, about 50% seats will be allocated to military officers. However, in case of the requirement of military students vacancy is less in any particular year, the deficient vacancy will be filled up by civil students. MIST also maintains quota as mentioned below:

Ser	**Quota Allocation**	**Seats**
1	General Candidates	54%
2	Children of Military Personnel	40%
3	Children of Freedom Fighters	2%
4	Tribal Citizen	1%
5	International Students	3%
	Total=	100%

1.6 Admission Procedure

1.6.1 Syllabus for Admission Test.

Admission test will be conducted on the basis of the syllabus of Mathematics, Physics, Chemistry and English (comprehension and functional) subjects of HSC examinations of all boards of secondary and higher secondary school certificates. Admission test will be conducted out of 200 marks and the distribution of marks is given below:

Ser.	Subjects	Marks
a.	Mathematics	90
b.	Physics	70
c.	Chemistry	30
d.	English	10
	Total=	200

1.6.2 Final Selection

Students will be selected on the basis of results of the admission test. The individual choice for selection of departments will be given preference as far as possible. In case of tie in the result of admission test, the difference will be judged on the basis of marks obtained in Mathematics, Physics, Chemistry and English respectively in admission test.

1.6.3 Medical Checkup

Civil candidates selected through admission test will go for medical checkup in MIST/CMH. If the medical authority considers any candidate unfit for study in MIST due to critical/contagious/mental diseases as shown in medical policy of MIST will be declared unsuitable for admission.

1.7 Students Withdrawal Policy

1.7.1 For Poor Academic Performance

The undergraduate (B.Sc.) Engineering programs for all engineering disciplines are planned for 04 regular levels, comprising of 08 regular terms for Architecture program, it is planned for 3 & regular levels, comprising of 10 regular terms. It is expected that all students will earn degree by clearing all the offered courses in the stipulated time. In case of failure, the following policies will be adopted:

a. Students failing in any course/subject will have to clear/pass the said course/subject by appearing it in supplementary/self-study (for graduating student) examination as per examination policy.

b. Students may also retake the failed subject/course in regular term/short term as per Examination policy.

c. Maximum grading for supplementary/self-study examination etc. of failed subjects will be B+ as per examination policy.

d. One student can retake/reappear in a failed subject/course only twice. However, with the Permission of Academic Council of MIST, a student may be allowed for third time as last chance.

e. In case of sickness, which leads to missing of more than 40% classes or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw temporarily from that term and repeat the whole level with the regular level in the next academic session, subject to the approval of Academic Council, MIST. However, he/she has to complete the whole undergraduate program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

f. Minimum credit requirement for the award of bachelor's degree in Engineering (B.Sc. Engg) and Architecture (B. Arch) will be decided by the respective department as per existing rules. However, the minimum CGPA requirement for obtaining a bachelor degree in engineering and Architecture is 2.20.

g. Whatever may be the cases, students have to complete the whole undergraduate Program within 06 (six) academic years from the date of registration.

h. All other terms and condition of MIST Examination Policy remain valid.

1.7.2 Withdrawal on Disciplinary Ground

a. Unfair Means. Adoption of unfair means may result in expulsion of a student from the programme and so from the Institution. The Academic Council will authorize such expulsion on the basis of recommendation of the Disciplinary Committee, MIST and as per policy approved by the affiliating university. Following would be considered as unfair means adopted during examinations and other contexts:

- Communicating with fellow students for obtaining help in the examination

- Copying from another student's script/ report /paper
- Copying from desk or palm of a hand or other incrimination documents
- Possession of any incriminating document whether used or not

b. **Influencing Grades.** Academic Council may expel/withdraw any student for approaching directly or indirectly in any form to influence a teacher or MIST authority for grades.

c. **Other Indiscipline Behaviors.** Academic Council may withdraw/expel any student on disciplinary ground if any form of indiscipline or unruly behavior is seen in him/her which may disrupt the academic environment/program or is considered detrimental to ' 'MIST's image.

d. **Immediate Action by the Disciplinary Committee of MIST.** The Disciplinary Committee, MIST may take immediate disciplinary action against any student of the institution. But later the approval of BUP has to be taken. In case of withdrawal/expulsion, the matter will have to be referred later to the next academic Council, MIST.

1.7.3 Withdrawal on Own Accord.

a. **Permanent Withdrawal.** A student who has already completed some courses and has not performed satisfactorily may apply for a withdrawal.

b. **Temporary Withdrawal.** A student, if he/she applies, may be allowed to withdraw temporarily from the program, subject to approval of Academic Council of MIST, but he/she has to complete the whole program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

c. **Permanent Expulsion** The term 'Permanent Expulsion' means expulsion permanently from the institution on disciplinary ground. A student, if expelled permanently will never be allowed to re-enter the course or similar program in MIST and be subjected to other terms and conditions as set by the authority while approving the permanent expulsion order.

d. **Temporary Expulsion** The term 'Temporary Expulsion' means expulsion from an academic course/program for a certain period on disciplinary ground. A student, if expelled temporarily, may be allowed to re-enter the course/program on expiry of the punishment period and on fulfilment of other terms and conditions (if any) as set by the authority while approving the temporary expulsion order.

CHAPTER 2

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAMS AT MIST

2.1 Introduction

MIST has introduced course system for undergraduate studies from the academic session 2017-18. Therefore, the rules and regulations mentioned in this paper will be applicable to students for administering undergraduate curriculum through the Course System. This will be introduced with an aim of creating a continuous, even and consistent workload throughout the term for the students.

2.2 The Course System

a. The salient features of the Course System are as follows:

Number of theory courses will be generally 5 in each term. However, with the recommendation of course coordinator and Head of the Department, Commandant MIST may allow relaxation in this regard. This relaxation is to be reported to Academic Council of MIST.

1) Students will not face any level repeat for failing

2) Students will get scope to improve their grading

3) Introduction of more optional courses to enable the students to select courses according to their individual needs and preferences

4) Continuous evaluation of 'students' performance

5) Promotion of student-teacher interaction and contact

b. Beside the professional courses pertaining to each discipline, the undergraduate curriculum gives a strong emphasis on acquiring thorough knowledge in the basic sciences of mathematics, physics and chemistry. Due importance is also given on the study of several subjects in humanities and social sciences.

c. The first two years of ' 'bachelor's degree programs generally consist of courses on basic engineering, general science and humanities subjects; while the third and subsequent years focus on specific disciplines.

2.3 Number of Terms in a Year

There will be two terms Spring Term (Jan-Jun) and Fall Term (Jul-Dec) in an academic year.

2.4 Duration of Terms

The duration of each of Spring Term and Fall Term (maximum 22 weeks) may be as under:

Ser	Events	Duration
1.	Classes before Midterm	7 weeks
2.	Midterm Vacation	1 week
3.	Classes after Midterm	7 weeks
4.	Makeup Classes and Preparatory leave	2/3 weeks
5.	Term Final Examination	2/3 weeks
6.	Term End Vacation	1/2 weeks

2.5 Course Pattern and Credit Structure

The undergraduate program is covered by a set of theoretical courses along with a set of laboratories (sessional) courses to support them.

2.6 Course Designation System

Each course is designated by a maximum of four-letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

a. The first digit corresponds to the year/level in which the course is normally taken by the students.

b. The second digit is reserved for departmental use. It usually identifies a specific area/group of study within the department.

c. The last digit is an odd number for theoretical courses and an even number for sessional courses.

The course designation system is illustrated as follows:

BME 1 0 1 **Introduction to Biomedical Engineering**

Course Title

Odd digit designates a theoretical course

Reserved for departmental use

Signifies 1st Year/ 1st Level course

Department Identification

BME 2 0 5 **Human Physiology**

Course Title

Odd digit designates a theoretical course

Reserved for departmental use

Signifies 2nd Year/ 1st Level course

Department Identification

2.7 Assignment of Credits

The assignment of credits to a theoretical course follows a different rule from that of a sessional course.

a. **Theoretical Courses:** One lecture per week per term is equivalent to one credit.

b. **Sessional Courses:** Credits for sessional courses is half of the class hours per week per term.

c. Credits are also assigned to project and thesis work taken by the students. The amount of credits assigned to such work varies from one discipline to another.

2.8 Types of Courses

The types of courses included in the undergraduate curricula are divided into the following groups:

a. **Core Courses:** In each discipline, a number of courses are identified as core courses, which form the nucleus of the respective bachelor's degree program. A student has to complete all designated core courses of his/her discipline.

b. **Prerequisite Courses:** Some of the core courses are identified as prerequisite courses for a specific subject.

c. **Optional Courses:** Apart from the core courses, the students can choose from the set of optional courses. A required number of optional courses from a specified group have to be chosen.

2.9 Course Offering and Instruction

a. The courses to be offered in a particular term are announced and published in the Course Catalog along with the tentative Term Schedule before the end of the previous term. The courses to be offered in any term will be decided by Board of Undergraduate Studies (BUGS) of the respective department.

b. Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of 'students' performance. Depending on the strength of registered students (i.e. on the number of students) enrolled for the course, the teacher concerned might have course associates and Teaching Assistants (TA) to aid in teaching and assessment.

2.10 Teacher Student Interaction

The new course system encourages students to come in close contact with the teachers. For promotion of a high level of teacher-student interaction, each student is assigned to an adviser and the student is free to discuss all academic matters with his/her adviser. Students are also encouraged to meet any time with other teachers for help and guidance in academic matters. However, students are not allowed to interact with teachers after the moderation of questions.

2.11 Student's Adviser

a. One adviser is normally appointed for a group of students by the BUGS of the concerned department. The adviser advises each student about the courses to be taken in each term by discussing the academic program of that particular term with the student.

b. However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the ' 'student's specific plan of study and monitor subsequent progress of the student.

c. For a student of second and subsequent terms, the number and nature of courses for which he/she can register are decided on the basis of academic performance during the previous term. The adviser may permit the student to drop one or more courses based on previous academic performance.

2.12 Course Registration

Any student who uses classroom, laboratory facilities or faculty-time is required to register formally. Upon admission to the MIST, students are assigned to advisers. These advisers guide the students in choosing and registering courses.

2.12.1 Registration Procedure

At the commencement of each term, each student has to register for courses in consultation with and under the guidance of his/her adviser. The date, time and venue of registration are announced in advance by the ' 'Registrar's Office. Counseling and advising are accomplished at this time. It is absolutely essential that all the students be present for registration at the specified time.

2.12.2 Pre-conditions for Registration

a. For first year students, department-wise enrollment/admission is mandatory prior to registration. At the beginning of the first term, an orientation program will be conducted for them where they are handed over with the registration package on submission of the enrolment slip.

b. Any student, other than the new batch, with outstanding dues to the MIST or a hall of residence is not permitted to register. Each student must clear their dues and obtain a clearance certificate, upon production of which, he/she will be given necessary Course Registration Forms to perform course registration.

c. A student is allowed to register in a particular course subject to the class capacity constraints and satisfaction of prerequisite courses. However, even if a student fails in a prerequisite course in any term, the concerned department (BUGS) may allow him/her to register for a course which depends upon the prerequisite course provided that his/her attendance and performance in the continuous assessment of the mentioned prerequisite course is found to be satisfactory.

2.12.3 Registration Deadline.

Each student must register for the courses to be taken before the commencement of each term. Late registration is permitted only during the first week of classes. Late registration after this date will not be accepted unless the student submits a written application to the registrar through the concerned Head of the department explaining the reasons for delay. Acceptable reasons may be medical problems with supporting documents from the Medical Officer of MIST or some other academic commitments that prohibit enrollment prior to the last date of registration.

2.12.4 Penalty for Late Registration

Students who fail to register during the designated dates for registration are charged a late registration fee of Tk. 100.00 (One hundred only) per credit hours. Penalty for late registration will not be waived.

2.12.5 Limits on the Credit Hours to be taken

a. A student should be enrolled for at least 15 credit hours and is allowed to take a maximum of 24 credit hours. Relaxation on minimum credit hours may be allowed. A student must enroll for the sessional courses prescribed in a particular term within the allowable credit hour limits.

b. In special cases where it is not possible to allot the minimum required 15 credit hours to a student, the concerned department (BUGS) may permit with the approval of the Comdt, a lesser number of credit hours to suit individual requirements. Such cases are also applicable to students of Level 4 requiring less than 15 credit hours for graduation.

2.12.6 Course Add/Drop

a. A student has some limited options to add or drop courses from the registration list. Addition of courses is allowed only within the first two weeks of a regular term and only during the first week of a short term. Dropping a course is permitted within the first four weeks of a regular term and two weeks of a short term.

b. Any student willing to add or drop courses has to fill up a Course Adjustment Form. This also has to be done in consultation with and under the guidance of the ' 'student's respective adviser. The original copy of the Course Adjustment Form has to be submitted to the ' 'Registrar's Office, where the required numbers of photocopies are made for distribution to the concerned adviser, Head, Dean, Controller of Examinations and the student.

c. All changes must be approved by the adviser and the Head of the concerned department. The Course Adjustment Form has to be submitted after being signed by the concerned persons.

2.12.7 Withdrawal from a Term

If a student is unable to complete the Term Final Examination due to serious illness or serious accident, he/she may apply to the Head of the degree-awarding department for total withdrawal from the term before commencement of term final examination. However, application may be considered during term final examination in special case. The application must be supported by a medical certificate from the Medical Officer of MIST. The concerned student may opt for retaining the sessional courses of the term. The Academic Council will take the final decision about such applications. However, the total duration for graduation will not exceed 6 academic years.

2.13 The Grading System

The total performance of a student in a given course is based on a scheme of continuous assessment, for theory courses this continuous assessment is made through a set of quizzes, class tests, class evaluation, class participation, homework assignment and a term final examination. The assessments for sessional courses are made by evaluating performance of the student at work during the class, viva-voce during laboratory hours and quizzes. Besides that, at the end there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightages. A student's performance is measured by the number of credits completed satisfactorily and by the weighted average of the grade points earned. A minimum grade point average (GPA) is essential for satisfactory progress. A minimum number of earned credits also have to be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be given as follows:

Numerical Markings	Grade	Grade Points
80% and above	A+	4.00
75% to below 80%	A	3.75
70% to below 75%	A-	3.50
65% to below 70%	B+	3.25
60% to below 65%	B	3.00
55% to below 60%	B-	2.75
50% to below 55%	C+	2.50
45% to below 50%	C	2.25
40% to below 45%	D	2.00
below 40%	F*	0.00
Incomplete	I	-
Withdrawal	W	-
Capstone Project/Thesis Continuation	X	-

*Subject in which the student gets F grade shall not be regarded as earned credit hours for the calculation of Grade Point Average (GPA).

2.14 Distribution of Marks

2.14.1 Theory

Forty percent (40%) of marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments, class tests, observations/ class participation and class attendance. This mark must be submitted to Office of the Controller of Examinations before commencement of final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of final examination will be three (03) hours. The scheme of continuous assessment that a particular teacher would follow for a course will be announced on the first day of the classes.

Distribution of marks for a given course per credit is as follows	Marks
Class Performance	5%
Class Attendance	5%
Class Test/ Assignment	20%
Midterm Assessment (Exam/Project)	10%
Final Examination (Section A & B)	60%
Total =	100%

Note:

a. In final exam, each section can be used for achieving not more than two course outcomes (COs). The remaining COs should be attained from mid-term assessment or class tests. Course teacher has to inform the student the beginning of the terms.

b. Course teacher of a particular course has to inform the department whether he/she wants to assess mid-term through exam or project within first two weeks of beginning of a term. The duration of mid-term examination should not be more than 50 minutes which has to be conducted in between 6th to 9th week of a semester. If mid-term assessment is done through project, then there should be project report and presentation.

c. The weightage of class performance can be assessed through checking attentiveness during classes or arranging unnoticed pop quizzes.

d. The number of class tests shall be n for 3.0 and above credit courses and (n-1) shall be considered for grading where n is the number of credits of the course. However, for courses having credits below 3.0, the considered class tests shall be 2 out of 3.

e. All class test will carry 20 marks each. Exam software system will finally convert these achieved marks into total class test marks as per credit hour. i.e for n=1(20), n=2 (40), n=3 (60), n=4(80), etc.

f. Irrespective of the result of the continuous assessment (class performance, class test, mid-term assessment), a student has to appear in the final examination (where applicable) for qualifying/passing the concern course/ subject.

2.14.2 Laboratory/Sessional/Practical Examinations

Laboratory/ Sessional courses are designed and conducted by the concerned departments. Examination on sessional/practical subjects will be conducted by the respective department before the commencement of term final examination. The date of practical examination will be fixed by the respective department. Students will be evaluated in the laboratory/ sessional courses on the basis of the followings:

a.	Conduct of Lab Tests/Class Performance	25%
b.	Report Writing/ Programming	15%
c.	Mid-Term Evaluation (exam/project/assignment)	20%
d.	Final Evaluation (exam/project/assignment)	30%
e.	Viva Voce/ Presentation	10%
	Total Percentage=	100%

Note: the above distribution of percentage is a general guideline. Department can rearrange to some extent if required.

2.14.3 Sessional Course in English

The distribution will be as under:

a.	Class performance/observation	10
b.	Written Assignment	15
c.	Oral Performance	25
d.	Listening Skill	10
e.	Group Presentation	30
f.	Viva Voce	10
	Total Percentage=	100%

2.14.4 Class Attendance

Class attendance may be considered as a part of continuous assessment. No mark should be allotted for attending classes.

<u>Collegiate and Non-collegiate</u>

Students having class attendance of 85% or above in individual subject will be treated as collegiate, and less than 85% and up to 70% will be treated as non-collegiate in that subject. The non-collegiate student(s) may be allowed to appear at the examination subject to payment of non-collegiate fee/fine of an amount fixed by MIST/BUP. Students having class attendance below 70% will be treated as dis-collegiate and will not be allowed to appear at the examination and treated as fail. But in a special case such students may be allowed to appear in the examination with the permission of Commandant and it must be approved by the Academic Council.

2.14.5 Calculation of GPA

Grade Point Average (GPA) is the weighted average of the grade points obtained of all the courses passed/completed by a student. For example, if a student passes/completes n courses in a term having credits of C_1, C_2, ..., C_n and his grade points in these courses are G_1, G_2, ..., G_n, respectively, then

$$GPA = \frac{Grade\ points\ earned\ in\ the\ semester}{Credits\ completed\ in\ the\ semester}$$

$$= \frac{Summation\ of\ (Credit\ hours\ in\ a\ course * Grade\ point\ earned\ in\ that\ course)}{Total\ number\ of\ credit\ hours\ completed}$$

$$= \frac{\sum_{i=1}^{n} Ci * Gi}{\sum_{i=1}^{n} Ci}$$

The Cumulative Grade Point Average (CGPA) is the weighted average of the GPA obtained in all the terms passed/completed by a student. For example, if a student passes/ completes n terms having total credits of TC_1, TC_2, ... , TC_n and his GPA in these terms are GPA_1, GPA_2,... , GPA_n, respectively then

$$CGPA = \frac{\sum_{i=1}^{n} TCi * GPAi}{\sum_{i=1}^{n} TCi}$$

<u>Numerical Example</u>

Suppose a student has completed eight courses in a term and obtained the following grades:

Course	Credits, C_i	Grade	Grade, G_i	Points, C_iG_i
BME 101	2.0	A-	3.50	7.00
PHY 125	3.0	A+	4.00	12.00

PHY 128	1.5	A	3.75	5.625
CHEM 103	3.0	B	3.00	9.00
CHEM 104	1.5	B-	2.75	4.125
MATH 101	3.0	A+	4.00	12.00
LANG 102	1.5	A	3.75	5.625
GES 101	2.0	A+	4.00	8.00
GEBS 101	2.0	A-	3.50	7.00
Total	19.50			70.375

GPA = 70.375/19.50 = 3.60

Suppose a student has completed four terms and obtained the following GPA.

Level	Term	Credit Earned, TC_i	Hours GPA Earned, GPA_i	$GPA_i \times TC_i$
1	1	19.50	3.73	72.73
1	2	22.50	3.93	88.42
2	1	21.50	3.96	85.14
2	2	20.50	4.00	82.00
Total		**84.00**		328.30

CGPA = 328.30/84.00 = 3.90

2.14.6 Impacts of Grade Earned

d. The courses in which a student has earned a "'D' or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained an "'F' grade will not be counted towards his/her earned credits or GPA calculation. However, the "'F' grade will remain permanently on the Grade Sheet and the Transcript.

e. A student who obtains an "'F' grade in a core course will have to repeat that particular course. However, if a student gets an "'F' in an optional course, he/she may choose to repeat that course or take a substitute course if available. When a student will repeat a course in which he/she has previously obtained an "F', he/she will not be eligible to get a grade better than 'B+"" in that repeated course.

f. If a student obtains a grade lower than 'B+"" in a particular course he/she will be allowed to repeat the course only once for the purpose of grade improvement. However, he/she will not be eligible to get a grade better than 'B+"" for an improvement course.

g. A student will be permitted to repeat for grade improvement purposes a maximum of 6 courses in BSc. Engineering programs and a maximum of 7 courses in B. Arch. program.

h. If a student obtains a 'B+"" or a better grade in any course he/she will not be allowed to repeat the course for the purpose of grade improvement.

2.15 Classification of Students

At MIST, regular students are classified according to the number of credit hours completed/ earned towards a degree. The following classification applies to all the students:

Level	Credit Hours Earned	
	Engineering	***Architecture***
Level 1	0.0 to 36.0	0.0 to 34.0
Level 2	More than 36.0 to 72.0	More than 34.0 to 72.0
Level 3	More than 72.0 to 108.0	More than 72.0 to 110.0
Level 4	More than 108.0	More than 110.0 to 147.0
Level 5		More than 147.0

However, before the commencement of each term all students other than new batch are classified into three categories:

a. Category 1: This category consists of students who have passed all the courses described for the term. A student belonging to this category will be eligible to register for all courses prescribed for the upcoming term.

b. Category 2: This category consists of students who have earned a minimum of15 credits but do not belong to category 1. A student belonging to this category is advised to take at least one course less since he might have to register for one or more backlog courses as prescribed by his/her adviser.

c. Category 3: This category consists of students who have failed to earn the minimum required 15 credits in the previous term. A student belonging to this category is advised to take at least two courses less than a category 1 student subject to the constraint of registering at least 15 credits. However, he will also be required to register for backlog courses as prescribed by the adviser.

2.15.1 Definition of Graduating Student

Graduating students are those students who will have ≤ 24 credit hour for completing the degree requirement.

2.16 Performance Evaluation

a. The performance of a student will be evaluated in terms of two indices, viz. Term Grade Point Average and Cumulative Grade Point Average which is the grade average for all the terms completed.

b. Students will be considered to be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.20 or higher. Students who regularly maintain a term GPA of 2.20 or better are making good progress toward the degrees and are in good standing with MIST. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists:

1) The term GPA falls below 2.20.

2) The Cumulative Grade Point Average (CGPA) falls below 2.20.

3) The earned number of credits falls below 15 times the number of terms attended.

c. All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent term(s) and backlog courses, if there are any, with better grades. When the minimum GPA and credit requirements are achieved the student is again returned to good standing.

2.17 Application for Graduation and Award of Degree

A student who has fulfilled all the academic requirements for 'Bachelor's degree will have to apply to the Controller of Examinations through his/her Adviser for graduation. Provisional Degree will be awarded by BUP on completion of credit and GPA requirements.

2.17.1 Minimum Earned Credit and GPA Requirement for Obtaining Degree

a. Minimum credit hour requirements for the award of Bachelor’s degree in engineering (BSc Engg) and architecture (B Arch) will be decided by the respective department (BUGS). However, the syllabus of all BSc engineering prog must be of minimum 157 credit hours or more and for architecture prog minimum 189 credit hours or more. A student must earnsearn minimum credit hour set in the syllabus by the concerned department for qualifying Bachelor's Degree. The minimum CGPA requirement for obtaining a Bachelor's degree in engineering and architecture is 2.20.

b. A student may take additional courses with the consent of his/her Adviser in order to raise CGPA, but he/she may take a maximum of 15 such additional credits in engineering and 18 such additional credits in architecture beyond respective credit-hour requirements for Bachelor's degree during his/her entire period of study.

2.17.2 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor's degree in engineering (B.Sc. Engineering) and other discipline will be decided as per existing rules. The minimum GPA requirement for obtaining a Bachelor's degree in Engineering and Architecture is 2.20.

2.18 Time Limits for Completion of Bachelor's Degree

A student must complete his studies within a maximum period of six years for engineering and seven years for architecture.

2.19 Attendance, Conduct and Discipline

MIST has strict rules regarding the issues of attendance in class and discipline.

a. **Attendance:** All students are expected to attend classes regularly. The university believes that attendance is necessary for effective learning. The first responsibility of a student is to attend classes regularly and one is required to attend the classes as per MIST rules.

b. **Conduct and Discipline:** During their stay in MIST all students are required to abide by the existing rules, regulations and code of conduct. Students are strictly forbidden to form or be members of student organization or political party, club, society etc., other than those set up by MIST authority in order to enhance ' 'student's physical, intellectual, moral and ethical development. Zero tolerance in regards of sexual abuse and harassment in any forms and drug abuse and addiction are strictly observed in the campus.

2.20 Teacher-Student Interaction

The academic system in MIST encourages students to come in close contact with the teachers. For promotion of high level of teacher-student's interaction, a course coordinator is assigned to each course. Students are free to discuss with CC about all academic matters. Students are also encouraged to meet other teachers any time for help and guidance for academic matters. Heads of the departments, Director of Administration, Director of Students Welfare (DSW), Dean and Commandant address the students at some intervals. More so, monthly Commandant's Parade is organized in MIST where all faculty members, staff and students are formed up, thereby increasing teacher-student interaction.

2.21 Absence During a Term

A student should not be absent from quizzes, tests, etc. during the term. Such absence will naturally lead to reduction in points/marks, which count towards the final grade. Absence in the Term Final Examination will result in an F grade in the corresponding course. A student who has been absent for short periods, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for make-up quizzes or assignments immediately upon return to classes. Such request has to be supported by medical certificate from competent authority (e.g. CMH/MIST Medical Officer).

2.22 Recognition of Performance

As recognition of performance and ensure continued studies MIST awards medals, scholarships and stipends will be given as per existing rules and practices.

2.23 Types of Different Examination

Following different types of final Examinations will be conducted in MIST to evaluate the students of Undergraduate Programs:

a. **Term Final Examination:** At the end of each normal term (after 22week or so), Term Final Examination will be held. Students will appear in the Term Final Examination for all the theory courses they have taken in the Term.

b. **Supplementary Examination:** It will take place twice in a year. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun)/Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec)/ Spring Term (Jan-Jun) end break, respectively. Students will be allowed to register for a maximum of two theory courses (Failed/ Improvement) in Supplementary-I and maximum of one theory course (Failed/ Improvement) in Supplementary-II.

c. **Improvement Examination:** It will be taken during Supplementary-I and Supplementary-II Examination. Questions will be same as the question of the regular examination of that Supplementary Examination (if any). Student can take maximum two subjects at a time (two subjects in Supplementary-I and one subject in Supplementary-II) and maximum 6 subjects in the whole academic duration. If a student obtains a grade lower than ‘B+’ in a course, he/she will be allowed to repeat the course only once for grade improvement.

However, he/she will not be eligible to get a grade better than 'B+' for an improvement course. Among the previous result and improvement examination result, best one will be considered as final result for an individual student. However, performance of all examination i.e. previous to improvement examination shall be reflected in the transcript.

2.24 Rules of Different Examinations

2.24.1 Term Final Examination

Following rules to be followed:

a. Registration to be completed before commencement of the class. A student has to register his desired courses paying registration, examination fee and other related fees.

b. Late registration will be allowed without penalty within first one week of the term.

c. Within 1st two weeks of a term a student can Add/Drop course/courses. To add a course, in the 3rd week, one has to register the course by paying additional fees. To drop a course, one has to apply within three weeks and paid fees will be adjusted/ refunded. If anyone wants to drop a course after three weeks and within 4 weeks, that will be permitted but paid fees will not be refunded in that case.

d. Registrar office will finalize registration of all courses within 7 (seven) weeks, issue registration slip and that will be followed by issuing Admit Card.

e. Term Final Examination to be conducted in the 18-20th week of the term as per approved Academic Calendar.

2.24.2 Supplementary Examination

Following rules to be followed:

a. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) /Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively.

b. Students will be allowed to register for a maximum of two theory courses (Failed/ Improvement) in Supplementary-I and maximum of one theory course (Failed/ Improvement) in Supplementary-II.

c. No class will be conducted.

d. 40% marks will be considered from the previous exams.

e. Maximum grading in Supplementary Exam will be 'B+'.

f. No Sessional Exam will be conducted.

g. Examination will be taken on 60% marks like Term Final Examination.

h. If a student fails in a course more than once in regular terms, then for calculating 40% marks, the best one of all continuous assessment marks will be counted.

i. If anyone fails in the Laboratory/ Sessional course, that course cannot be taken in the supplementary examination.

j. If any student fails in a course, he can clear the course retaking it second time or, he can clear the examination appearing at the Supplementary Examination as well. Anyone fails twice in a course, can only retake it in the regular term for appearing third time. But anyone fails even after appearing third time, he/she has to take approval of Academic Council of MIST for appearing 4th (last) time in a course and need to pay extra financial penalty. If any student fails even 4th time in a course, will not be allowed to appear anymore in this same course.

k. Registration of Supplementary-I Exam to be done within 5th week after completion of fall Term (Jul-Dec) and registration of Supplementary-II Exam to be done within the mid-term break of Spring Term (Jan-Jun), paying all the required fees.

l. There will be no provision for add/drop courses after registration.

m. **Thesis:** if a student cannot complete thesis in two consecutive terms, with the recommendation of the supervisor, he/she may continue for next one/two term within six academic years.

2.24.3 Improvement Examination

Following rules to be followed:

a. Improvement Examination is to be taken during the Supplementary-I and II examinations.

b. For Improvement Examination, registration is to be done during the registration of Supplementary-I and Supplementary-II Examinations by paying all the fees.

c. Question Setting, Moderation and Result Publication to be done with courses of Supplementary-I and Supplementary-II Examinations.

d. Any student gets a grading below 'B+' and desires to improve that course, he will be allowed to appear the Improvement Examination for that particular course.

e. Highest grade of Improvement Examination will be 'B+'.

f. One student is allowed to appear at Improvement Exam in 6 (six) courses in his whole graduation period taking maximum two courses at a time (two courses at Supplementary-I and one course at Supplementary-II).

2.25 Irregular Graduation

If any graduating student clears his/her failed course in Term-1 (Spring) and his graduation requirements are fulfilled, his graduation will be effective from the result publication date of Term-1 (Spring) and that student will be allowed to apply for provisional certificate.

2.26 Minimum Earned Credit and CGPA Requirement for Obtaining Degree

The requirements for award of engineering degree are as follows:

a. Completion of the courses for the minimum required credits of 157 (or as specified in a particular department) in a maximum period of six academic years.

b. Appearing at the final examination in all the required courses as per syllabus of the program.

c. Scoring a CGPA of 2.2 or above.

2.27 Consequences of Failing in Sessional Courses

Any student failing in any sessional course must re-take that sessional course when offered by the department in any next Regular Term. No Supplementary exam is allowed for sessional course.

2.28 Withdrawal for Poor Performance

A student to remain in reasonable standing must maintain a minimum CGPA of 2.20. Failure to secure/achieve minimum CGPA of 2.20 in two consecutive levels will also lead to withdrawal of the student. A student who fails to maintain a CGPA of 2.20 at the end of a level, but obtains 2.00 or more, will be placed on probation. Failure by a student placed on probation to raise the CGPA to 2.20 in the next level will lead to his withdrawal from the Program. A student failing to maintain a CGPA of 2.20 at the end of the level-4 shall be allowed to repeat courses of the level-4 in which he earned 'C' grades or below. This opportunity will be given only once. Such a student failing to raise CGPA to 2.2 after repeating the courses will be withdrawn from the Program (For further detail 'MIST Withdrawal Policy' may be consulted).

a. **Voluntary withdrawal for Sickness.** In case of sickness which leads to missing of more than 40% class or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw from that term subject to the approval of the Academic Council of MIST. Students may retain sessional courses of that term if applies and approved by Academic council. ‘VW’ as grading of each course to be reflected in concerned tabulation sheet, grade sheet and transcript.

b. **Class Tests.** The number of class tests shall be n for 3.0 and above credit courses and (n-1 shall be considered for grading where n is the number of credits of the course. However, for courses having credits below 3.0, the considered class tests shall be 2 out of 3. Class test will be conducted by the subject teacher. Duration of class test should not be more than 30 minutes. Course teacher must announce results within 10 days of holding the examination. Checked script will be shown to the students. If a student misses the class test for acceptable reason the course teacher my take the test of the student.

c. MIST is committed in conferring degrees to the students in time which plays a very vital role in steering all the academic activities in any university/ institute. At the beginning MIST conducted all its examinations under the examination section of the University of Dhaka. In June 2008, MIST got affiliation with BUP. Since then MIST has been conducting all its examinations under the control and authority of BUP. For the need of time, former MIST examination policy was reviewed several times. Present review committee has made necessary amendment/ addition/ deletion to suit the proposed course system. This policy may be reviewed every after 05 (five) years or as and when felt necessary by the authority of MIST.

2.29 SUMMARY OF MIST EXAMINATION POLICY-2020

Serial	Examination Type	Session	Number of Theory Courses	Maximum Grading	Assessment Percentage	Examination Schedule	Courses	Registration Schedule
1	Regular	Spring Term (Jan-Jun) and Fall Term (Jul-Dec)	Maximum 6 Theory Courses	A+	Assessment on 100%	Regular Examination	Regular	Regular
2	Retake	Spring Term (Jan-Jun) and Fall Term (Jul-Dec)		B+				
3	Supplementary-I (Fail/Improvement)	Spring Term (Jan-Jun)	Maximum 2 Theory	B+	Assessment on 60%	1st week of Spring Term (Jan-Jun)/ Fall Term (Jul-Dec) End Break	Courses of immediate past terms included	5th week after completion of Fall Term (Previous Year)
4	Supplementary-II (Fail/Improvement)	Fall Term (Jul-Dec)	Maximum 1 Theory	B+	Assessment on 60%	1st week of Fall Term (Jul-Dec)/ Spring Term (Jan-Jun) End Break	Courses of immediate past terms not included	Mid-Term Break of Spring (Jan-Jun) Term (March)

1. Maximum 24 credit hour in one regular term (excluding Supplementary Exams).
2. Students may register maximum upto 7 (seven) theory courses in exceptional case, if department can accommodate within 24 credit hour.
3. Students can register maximum 6 (six) theory courses for improvement in his whole academic period.
4. Supplementary-I Exam to be considered as part of previous Academic Year.
5. Student appearing in Supplementary-I shall not be included in current graduation ceremony.

CHAPTER 3

DEPARTMENT OF BIOMEDICAL ENGINEERING (BME)

3.1 Introduction to the Program

The Department of Biomedical Engineering, MIST, was founded in 2014 and started the academic program of the pioneer batch of Undergraduate Biomedical Engineers in the country. The B.Sc Program commenced on 1st February, 2015 with 41 students. The M.Sc Program commenced on 4th November 2015 with 5 students. Currently, there are a total of 161 students in the B.Sc Program and a total of 37 students in the M.Sc Program. Biomedical Engineering (BME) is an interdisciplinary field that combines the design and problem-solving skills of engineering with medical and biological sciences to advance healthcare treatment. Deeply interdisciplinary, biomedical engineering applies modern approaches from the experimental life sciences in conjunction with theoretical and computational methods from engineering, mathematics, and computer science to the solution of biomedical problems of fundamental importance, such as human health. This field seeks to close the gap between engineering and medicine, combining the design and problem-solving skills of engineering with medical and biological sciences to advance healthcare treatment, including diagnosis, monitoring, and therapy. The current focus of the BME Department includes the development of biocompatible implants and prostheses, various diagnostic and therapeutic medical devices ranging from clinical equipment, common biomedical imaging equipment, cell & tissue engineering, regenerative tissue growth, pharmaceutical drugs, and therapeutics.

3.2 Vision and Mission of the Program

Vision:

To become a locally reputed and globally recognized Biomedical Engineering Department through nurturing excellence in teaching, research, and industrial partnership towards advanced cutting-edge healthcare technologies.

Mission:

a. To provide quality education in the emerging and extremely interdisciplinary field of Biomedical Engineering, utilizing up-to-date teaching and learning facilities contributing to advanced healthcare technologies.

b. To formulate and implement a modern academic curriculum to develop professionally sound and ethically strong Biomedical Engineers to provide dedicated services in the healthcare sector of the nation.

c. To facilitate innovative and industry-linked research platforms to foster the development of cutting-edge technologies and their proficient applications.

d. To improve the quality of common peoples' life in Bangladesh using knowledge and skills of modern science and technology.

3.3 Program Educational Objective (PEOs)

No	PEO Statement
PEO-1	Provide graduates mathematical, scientific, and engineering fundamentals and advanced knowledge of understanding in the sector of Biomedical Engineering including analysis techniques, design, developments, and implementation methodologies
PEO-2	Integrate technical and communicative knowledge with professional and industry-based education to build up successful professional careers in industry, government, and academia
PEO-3	Expose graduate's problem-solving skills and research-based education for life-long learning to adapt the innovation and changes.
PEO-4	Make the graduates capable of working in the broader area of technology, having the capability and responsibility of leadership and teamwork.
PEO-5	Enable the graduates to establish and run sustainable business enterprises along diverse career paths by creating, selecting, applying appropriate and modern technologies and tools.
PEO-6	Contribute the educational, cultural, social, technological and economic development of society through the ethical application of their knowledge and skills.

3.4 Program Outcomes

Based on the suggestion of the Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh, the Bachelor in Biomedical Engineering (BME) program will have the following learning outcomes:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using the first principles of mathematics, the natural sciences, and the engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal, and environmental concerns.

4. **Investigation:** Conduct investigations of complex problems, considering the design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to professional engineering practice.

7. **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate sustainable development knowledge.

8. **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and the norms of the engineering practice.

9. **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

10. **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multi-disciplinary environments.

12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

In addition to incorporating the above-listed POs, MIST also included the following Knowledge Profile (K1-K8) as an educational institution: may include additional outcomes in its learning programs. The ranges of Complex Problem Solving (P1 – P7) and Complex Engineering Activities (A1 – A5) that should be addressed in the program are summarized in the tables below.

Knowledge Profile (KP)

	Attribute
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

Range of Complex Engineering Problem Solving

Attribute	**Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7:
Depth of knowledge required	P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach

Range of conflicting requirements	P2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	P4: Involve infrequently encountered issues
Extent of applicable codes	P5: Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	P6: Involve diverse groups of stakeholders with widely varying needs
Interdependence	P7: Are high level problems including many component parts or sub-problems

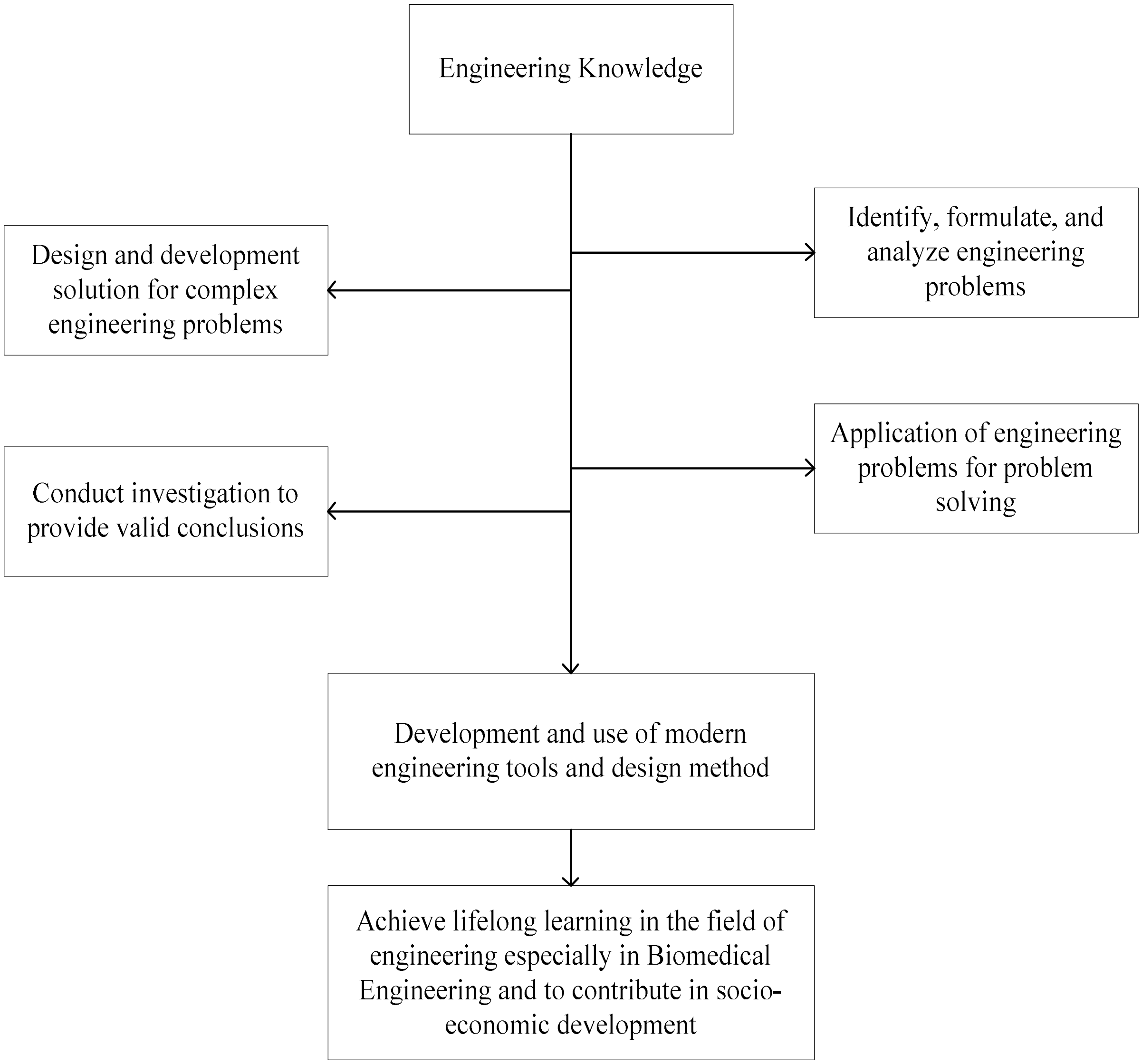
Range of Complex Engineering Activities

Attribute	**Complex activities** means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: Involve creative use of engineering principles and research based knowledge in novel ways
Consequences for society and the environment	A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

3.5 Generic Skills

1. Apply the principles and theory of biomedical engineering knowledge to the requirements, design and development of different biomedical equipment and devices with appropriate understanding.
2. Define and use appropriate research methods and modern tools to conduct a specific project.
3. Learn independently, be self- aware, and self- manage their time and workload.
4. Apply critical thinking to solve complex engineering problems
5. Analyze real time problems and justify the appropriate use of technology
6. Work effectively with others and exhibit social responsibility

3.6 Curriculum/ Skill Mapping



CHAPTER 4

COURSE CURRICULUM FOR BACHELOR DEGREE IN BME

4.1 Course Schedule

Keeping the above mentioned program outcome, the course schedule for the undergraduate students of the Biomedical Engineering (BME) is given below:

Level/ Term	Basic Science		Math	General Education		Engineering Courses				Elective Course	Total
						Dept.		Non-Dept.			
	T	S	T	T	S	T	S	T	S	T	
L-1 (Spring)	6.00	1.50	3.00	2.00	-	2.00	-	3.00	1.50	-	19.00
L-1 (Fall)	6.00	1.50	3.00	2.00	1.50	3.00	1.50	-	-	-	18.50
L-2 (Spring)	-	-	3.00	2.00	1.50	3.00	-	6.00	3.00	-	18.50
L-2 (Fall)	-	-	3.00	-	-	9.00	4.50	3.00	-	-	19.50
L-3 (Spring)	-	-	-	-	-	12.00	4.50	3.00	1.50	-	21.00
L-3 (Fall)	-	-	-	-	2.00	12.00	7.50	-	-	-	21.50
L-4 (Spring)	-	-	-	4.00	-	6.00	6.00	-	-	6.00	22.00
L-4 (Fall)	-	-	-	2.00	-	9.00	3.00	-	-	6.00	20.00
% of Total Course	9.375		7.50	10.625		51.875		13.125		7.50	100.00
Total Credit Hr	15.00		12.00	17.00		83.00		21.00		12.00	160.00

T=Theory; S=Sessional

Table: Summary of Course Curriculum

4.2 Contact Hours and Credit Hours Distribution in Eight Terms

Level/Term	Theory Contact Hours	Sessional Contact Hours	Theory Credit Hours	Sessional Credit Hours	Total Contact Hours	Total Credit Hours
L-1 (Spring)	16.00	6.00	16.00	3.00	22.00	19.00
L-1 (Fall)	14.00	9.00	14.00	4.50	23.00	18.50
L-2 (Spring)	14.00	9.00	14.00	4.50	23.00	18.50
L-2 (Fall)	15.00	9.00	15.00	4.50	24.00	19.50
L-3 (Spring)	15.00	12.00	15.00	6.00	27.00	21.00
L-3 (Fall)	12.00	16.00+4 Weeks	12.00	9.50	28.00+4 Weeks	21.50
L-4 (Spring)	16.00	12.00	16.00	6.00	28.00	22.00
L-4 (Fall)	17.00	6.00	17.00	3.00	23.00	20.00
Total	119.00	79.00+4 Weeks	119.00	41.00	198.00+4 Weeks	160.00

4.3 Final Year

Final Year Design and Research Project

Final year design and research project will have to be undertaken by students under separate supervisors in partial fulfillment of the requirement of his/her degree. Credits allotted to the final year design and research project will be 6.00 corresponding to 12.00 contact hours. Topic and advisor selection of final year design and research project must be finalized within level-3, term-2.

4.4 BME Courses

The students have to complete all the core courses listed below:

4.4.1 List of Core Courses – BME

Ser	Course Code	Course Name	Credit Hour
1	BME 101	Introduction to Biomedical Engineering	2.0
2	BME 104	CAD in Biomedical Engineering Sessional	1.5
3	BME 105	Human Anatomy	3.0
4	BME 201	Human Physiology	3.0
5	BME 203	Biochemistry	3.0
6	BME 204	Biochemistry Sessional	1.5
7	BME 205	Biofluid Mechanics and Heat Transfer	3.0
8	BME 206	Biofluid Mechanics and Heat Transfer Sessional	1.5
9	BME 207	Biomedical Instrumentation and Measurements	3.0
10	BME 208	Biomedical Instrumentation and Measurements Sessional	1.5
11	BME 301	Statistics and Numerical Methods for Biomedical Engineers	3.0
12	BME 302	Statistics and Numerical Methods for Biomedical Engineers Sessional	1.5
13	BME 303	Biomechanics	3.0
14	BME 304	Biomechanics Sessional	1.5
15	BME 305	Biomedical Signal Processing	3.0
16	BME 306	Biomedical Signal Processing Sessional	1.5
17	BME 307	Medical Imaging	3.0
18	BME 309	Biomedical Transport Phenomenon	3.0
19	BME 311	Embedded Systems and Interfacing	1.5
20	BME 312	Embedded Systems and Interfacing Sessional	3.0
21	BME 313	Biomedical Image Processing	1.5
22	BME 314	Biomedical Image Processing Sessional	3.0

23	BME 315	Biomaterials	3.0
24	BME 316	Biomaterials Sessional	1.5
25	BME 318	Biomedical Engineering Design Sessional I	1.5
26	BME 300	Industrial Training	1.5
27	BME 401	Diagnostic and Therapeutic Equipment	3.0
28	BME 403	Molecular Biology for Engineers	3.0
29	BME 404	Molecular Biology for Engineers Sessional	1.5
30	BME 405	Healthcare Technology Management	3.0
31	BME 407	Rehabilitation Engineering	3.0
32	BME 409	Tissue Engineering	3.0
33	BME 412	Biomedical Engineering Design Sessional II	1.5
33	BME 400	Final Year Design and Research Project	6.0
Total			**83.0**

4.4.2 List of Courses – Basic Science and Mathematics

Ser	Course Code	Course Name	Credit Hour
1	PHY 125	Waves and Oscillations, Optics and Modern physics	3.0
2	PHY 127	Structure of matter, Electricity, Magnetism, and Mechanics	3.0
3	PHY 128	Physics Sessional	1.5
4	CHEM 103	General Chemistry	3.0
5	CHEM 104	Chemistry Sessional	1.5
6	CHEM 125	Physical and Bio-organic Chemistry	3.0
7	MATH 101	Differential and Integral Calculus	3.0
8	MATH 105	Vector Analysis, Matrix and Coordinate Geometry	3.0
9	MATH 205	Differential Equation, Laplace transform and Fourier Transform	3.0
10	MATH 231	Complex Variables and Linear Algebra	3.0
Total			**27.0**

4.4.3 List of Courses – General Education or Non-Skill and Language/ Communicative Language

Ser	Course Code	Course Name	Credit Hour
1	LANG 102	Communicative English I	1.5
2	GES 101	Fundamentals of Sociology	2.0
3	GEBS 101	Bangladesh Studies	2.0
4	GELM 271	Leadership and Management	2.0
5	LANG 202/LANG 204	Communicative English II/Bangla Language and Literature	1.5
6	GERM 352	Fundamentals of Research Methodology (Sessional)	2.0
7	GEPM 481	Project Management and Finance	2.0
8	GESL 421	Environment, Sustainability and Law	2.0
9	GEEM 451	Engineering Ethics and Moral Philosophy	2.0
Total			**17.0**

4.4.4 List of Core Courses – Interdisciplinary

Ser	Course Code	Course Name	Credit Hour
1	EECE 191	Principles of Electrical Engineering	3.0
2	EECE 192	Principles of Electrical Engineering Sessional	1.5
3	EECE 291	Electronic Circuits and Devices	3.0
4	EECE 292	Electronic Circuits and Devices Sessional	1.5
5	EECE 391	Digital Electronics	3.0
6	EECE 392	Digital Electronics Sessional	1.5
7	ME 291	Principles of Mechanical Engineering	3.0
8	CSE 291	Computer Programming	3.0
9	CSE 292	Computer Programming Sessional	1.5
Total			**21.0**

4.4.5 BME Elective Courses

At least TWO elective courses must be taken from each group.

4.4.5.1 Group-I (Instrumentation)

Ser	Course Code	Course Name	Credit Hour
1.	BME 411	Physiological Control System	3.0
2.	BME 413	Virtual Bioinstrumentation	3.0
3.	BME 415	Biophotonics	3.0
4.	BME 417	Equipment in Radiology and Radiotherapy	3.0

4.4.5.2 Group-II (Regenerative Medicine)

Ser	Course Code	Course Name	Credit Hour
1.	BME 419	Drug Development and Delivery System	3.0
2.	BME 421	Nanotechnology in Biomedicine	3.0
3.	BME 423	Artificial Organ Development	3.0
4.	BME 425	Bioinformatics	3.0

4.4.5.3 Group-III (Imaging)

Ser	Course Code	Course Name	Credit Hour
1.	BME 427	Advanced Biomedical Signal Processing	3.0
2.	BME 429	Nuclear Medicine	3.0
3.	BME 431	Biomedical Data Science	3.0

4.4.5.4 Group-IV (Biomechanics and Rehabilitation Engineering)

Ser	Course Code	Course Name	Credit Hour
1.	BME 433	Advanced Biofluid Mechanics	3.0
2.	BME 435	Biomedical Implants and Braces	3.0
3.	BME 437	Neuroscience and Neural Engineering	3.0
4.	BME 439	Biofabrication	3.0

4.5 Term-wise Distribution of Courses

4.5.1 LEVEL 1, SPRING

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 101	Introduction to Biomedical Engineering	2.0	2.0
2.	PHY 125	Waves and Oscillations, Optics and Modern physics	3.0	3.0
3.	GES 101	Fundamentals of Sociology	2.0	2.0
4.	CHEM 103	General Chemistry	3.0	3.0
5.	CHEM 104	Chemistry Sessional	3.0	1.5
6.	MATH 101	Differential and Integral Calculus	3.0	3.0
7.	EECE 191	Principles of Electrical Engineering	3.0	3.0
8.	EECE 192	Principles of Electrical Engineering Sessional	3.0	1.5
Total			**22.0**	**19.0**

4.5.2 LEVEL 1, FALL

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 104	CAD in Biomedical Engineering Sessional	3.0	1.5
2.	BME 105	Human Anatomy	3.0	3.0
3.	PHY 127	Structure of matter, Electricity and Magnetism, and Mechanics	3.0	3.0
4.	CHEM 125	Physical and Bio-organic Chemistry	3.0	3.0
5.	MATH 105	Vector Analysis, Matrix and Coordinate Geometry	3.0	3.0
6.	PHY 128	Physics Sessional	3.0	1.5
7.	GEBS 101	Bangladesh Studies	2.0	2.0
8.	LANG 102	Communicative English I	3.0	1.5
Total			**23.0**	**18.5**

4.5.3 LEVEL 2, SPRING

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 201	Human Physiology	3.0	3.0
2.	MATH 205	Differential Equation, Laplace transform and Fourier Transform	3.0	3.0
3.	EECE 291	Electronic Circuits and Devices	3.0	3.0
4.	EECE 292	Electronic Circuits and Devices Sessional	3.0	1.5
5.	CSE 291	Computer Programming	3.0	3.0
6.	CSE 292	Computer Programming Sessional	3.0	1.5
7.	GELM 271	Leadership and Management	2.0	2.0
8.	LANG 202/LANG 204	Communicative English II/Bangla Language and Literature	3.0	1.5
Total			**23.0**	**18.5**

4.5.4 LEVEL 2, FALL

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 203	Biochemistry	3.0	3.0
2.	BME 204	Biochemistry Sessional	3.0	1.5
3.	BME 205	Biofluid Mechanics and Heat Transfer	3.0	3.0
4.	BME 206	Biofluid Mechanics and Heat Transfer Sessional	3.0	1.5
5.	BME 207	Biomedical Instrumentation and Measurements	3.0	3.0
6.	BME 208	Biomedical Instrumentation and Measurements Sessional	3.0	1.5
7.	ME 291	Principles of Mechanical Engineering	3.0	3.0
8.	MATH 231	Complex Variables and Linear Algebra	3.0	3.0
Total			**24.0**	**19.5**

4.5.5 LEVEL 3, SPRING

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 301	Statistics and Numerical Methods for Biomedical Engineers	3.0	3.0
2.	BME 302	Statistics and Numerical Methods for Biomedical Engineers Sessional	3.0	1.5
3.	BME 303	Biomechanics	3.0	3.0
4.	BME 304	Biomechanics Sessional	3.0	1.5
5.	BME 305	Biomedical Signal Processing	3.0	3.0
6.	BME 306	Biomedical Signal Processing Sessional	3.0	1.5
7.	BME 307	Medical Imaging	3.0	3.0
8.	EECE 391	Digital Electronics	3.0	3.0
9.	EECE 392	Digital Electronics Sessional	3.0	1.5
Total			**27.0**	**21.0**

4.5.6 LEVEL 3, FALL

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 309	Biomedical Transport Phenomenon	3.0	3.0
2.	BME 311	Embedded Systems and Interfacing	3.0	3.0
3.	BME 312	Embedded Systems and Interfacing Sessional	3.0	1.5
4.	BME 313	Biomedical Image Processing	3.0	3.0
5.	BME 314	Biomedical Image Processing Sessional	3.0	1.5
6.	BME 315	Biomaterials	3.0	3.0
7.	BME 316	Biomaterials Sessional	3.0	1.5
8.	BME 318	Biomedical Engineering Design Sessional I	3.0	1.5
9.	GERM 352	Fundamentals of Research Methodology (Sessional)	4.0	2.0
10.	BME 300	Industrial Training	4 weeks	1.5
Total			**28.0**	**21.5**

4.5.7 LEVEL 4, SPRING

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 401	Diagnostic and Therapeutic Equipment	3.0	3.0
2.	BME 403	Molecular Biology for Engineers	3.0	3.0
3.	BME 404	Molecular Biology for Engineers Sessional	3.0	1.5
4.	BME 4**	Elective 1	3.0	3.0
5.	BME 4**	Elective 2	3.0	3.0
6.	GESL 421	Environment, Sustainability and Law	2.0	2.0
7.	GEPM 481	Project Management and Finance	2.0	2.0
8.	BME 412	Biomedical Engineering Design Sessional II	3.0	1.5
9.	BME 400	Final Year Design and Research Project	6.0	3.0
Total			**28.0**	**22.0**

4.5.8 LEVEL 4, FALL

Ser	Course Code	Course Name	Contact Hour	Credit Hour
1.	BME 405	Healthcare Technology Management	3.0	3.0
2.	BME 407	Rehabilitation Engineering	3.0	3.0
3.	BME 409	Tissue Engineering	3.0	3.0
4.	BME 4**	Elective 3	3.0	3.0
5.	BME 4**	Elective 4	3.0	3.0
7.	GEEM 451	Engineering Ethics and Moral Philosophy	2.0	2.0
8.	BME 400	Final Year Design and Research Project	6.0	3.0
Total			**23.0**	**20.0**

4.5.9 List of Elective Courses

At least TWO elective courses must be taken from each group.

Group-I (Instrumentation)

Ser	Course Code	Course Name	Credit Hour
1.	BME 411	Physiological Control System	3.0
2.	BME 413	Virtual Bioinstrumentation	3.0
3.	BME 415	Biophotonics	3.0
4.	BME 417	Equipment in Radiology and Radiotherapy	3.0

Group-II (Regenerative Medicine)

Ser	Course Code	Course Name	Credit Hour
1.	BME 419	Drug Development and Delivery System	3.0
2.	BME 421	Nanotechnology in Biomedicine	3.0
3.	BME 423	Artificial Organ Development	3.0
4.	BME 425	Bioinformatics	3.0

Group-III (Imaging)

Ser	Course Code	Course Name	Credit Hour
1.	BME 427	Advanced Biomedical Signal Processing	3.0
2.	BME 429	Nuclear Medicine	3.0
3.	BME 431	Biomedical Data Science	3.0

Group-IV (Biomechanics and Rehabilitation Engineering)

Ser	Course Code	Course Name	Credit Hour
1.	BME 433	Advanced Biofluid Mechanics	3.0
2.	BME 435	Biomedical Implants and Braces	3.0
3.	BME 437	Neuroscience and Neural Engineering	3.0
4.	BME 439	Biofabrication	3.0

CHAPTER 5
COURSES OFFERED BY OTHER DEPARTMENTS

5.1 Department of Science and Humanities

5.1.1 Level-1, Spring

5.1.1.1 PHY 125 Waves and Oscillations, Optics and Modern Physics

COURSE INFORMATION			
Course Code Course Title	: PHY 125 :Waves and Oscillations, Optics and Modern Physics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome-Based Education (OBE)			
SYNOPSIS/RATIONALE			
This course is the basic physics in the field of waves and oscillations, optics and modern physics. The course will be emphasized the basic concepts, theories and solve quantitative problems which can be applicable in a wide spectrum of engineering disciplines.			
OBJECTIVE			
1. To define the different parameters, concepts, logical and critical thinking with scientific knowledge of waves and oscillations, optics and modern physics. 2. To explain the basic theories and laws of waves and oscillations, optics and modern physics. 3. To solve numerical and analytical problems regarding waves and oscillations, optics and modern physics.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome At the end of the course, a student should be able to	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **define** different basic laws and parameters in the field of waves and oscillations, optics and modern physics such as simple harmonic motion, damped oscillations, interference, diffraction, polarization, relativity, photoelectric effect, Compton effect, radioactivity, etc.	C1	1	-	-	1	T, MT, F
CO2	Be able to **explain** different basic theories in the field of waves and oscillations, optics and modern physics such as the SHM, damped motion, wave motion, interference, diffraction, polarization, special theory of relativity, Compton theory, nuclear transformation, nuclear reaction etc.	C2	1	-	-	1	T, MT, F
CO3	Be able to **solve** quantitative problems in the field of waves and oscillations, optics and modern physics such as SHM, damped motion, wave motion, interference, diffraction, polarization, relativity, photoelectric effect, Compton shift, radioactivity, etc.	C3, C4	1	-	-	2	T, F, MT, ASG

(CP – Complex Problems, CA – Complex Activities, KP – Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, CS – Case study, MT- Mid Term Exam, F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

Waves and Oscillations: Simple Harmonic Motion (SHM) and its properties, differential equation of a SHM and its solution, total energy and average energy of a body executing SHM, simple pendulum, torsional pendulum, spring-mass system, LC oscillatory circuit, two body oscillation and reduced mass, Composition of SHM, Damped oscillations, and its different condition, forced oscillations and its different condition, resonance, Wave motion : expression for a plane progressive wave, differential equation of wave motion, energy density of wave motion, average kinetic and potential energy of wave motion, Stationary wave.

Optics: Combination of lens, equivalent lens and power, Defects of images and different aberrations, Interference of light, Young's double slit experiment, interference in thin films, Newton's ring, Diffraction of light, Fraunhofer and Fresnel diffraction, diffraction by single slit and double slit, diffraction grating, Fraunhofer diffraction at a circular aperture, resolving power of optical instrument, Polarization of light, Brewster's law, Malus law, polarization by double refraction, Nicole prism, optical activity and polarimeters, Laser: spontaneous and stimulated emission.

Modern physics: Relativity : Frame of reference, postulates of special theory of relativity, Galilean transformation, Lorentz transformation, length contraction, time dilation, velocity addition, relativity of mass, mass energy relation, momentum energy relation, Photoelectric effect, Compton effect, de Broglie matter wave, Bohr atom model and explanation, atomic orbital and energy equation, classification of nuclei, nuclear mass and binding energy, Radioactivity, radioactive decay law, half-life, mean life, nuclear reaction, introduction to nuclear reactor

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to d**efine** different basic parameters in the field of Waves and Oscillations, Optics and Modern physics such as periodic motion, simple harmonic motion, undamped oscillations, interference, diffraction, polarization and prism, photoelectric effect, Compton effect, matter wave, atomic model, radioactive decay, fusion, fission etc.	√											
CO2	Be capable to **explain** different basic theories in the field of Waves and Oscillations, Optics and Modern physics such as the wave motion for different systems along with energy, different formula for interference, diffraction, polarization special theory of relativity, Compton theory, nuclear transformation, and nuclear reaction etc.	√											
CO3	Be skilled to **solve** quantitative problems in the field of Waves and Oscillations, Optics and Modern physics such as energy of wave motion, wavelength, diffraction pattern, relativistic energy, photon energy, Compton shift, nuclear binding energy etc.	√											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level of Matching	Justification
CO1-PO1	3	The conceptual knowledge of the natural sciences applicable to the engineering discipline
CO2-PO1	3	The theory-based knowledge of the natural sciences applicable to the engineering discipline
CO3-PO1	3	The numerical analysis based knowledge of the natural sciences applicable to the engineering

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	3
Final Examination	3
Total	132

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
Week-1	**Topic**	**CT – 1 and Midterm, Final**
Class-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, assessment of the course	
Class-2	Periodic motion, oscillatory motion, simple harmonic motion (SHM), properties of SHM, differential equations, general solution of SHM, graphical representation of SHM	
Class-3	Velocity, acceleration, phase and epoch, time period, frequency and angular frequency of SHM	
Week-2		
Class-4	Total energy and average energy of SHM, problems	
Class-5	Simple pendulum, torsional pendulum, spring-mass system	
Class-6	LC oscillatory circuit, two body oscillations, reduced mass	
Week-3		
Class-7	Composition of SHM	
Class-8	Composition of SHM, problems	
Class-9	Damped oscillations and its differential equation	
Week-4		
Class-10	Displacement equation of damped oscillations and its different conditions, electric damped oscillatory circuit	
Class-11	Forced oscillations and its differential equation, displacement equation of forced oscillations, resonance	

Class-12	Wave motion : expression for a plane progressive wave, differential equation of wave motion, particle velocity, wave velocity	**Midterm, Final**
Week-5		
Class-13	Energy density of a plane progressive wave, average energy in a plane progressive wave, problems	
Class-14	Stationary wave : node, anti-node, problems	
Class-15	Lens and combination of lenses, equivalent lens, power of lens, cardinal points	
Week-6		
Class-16	Defects of images and different aberrations	
Class-17	Defects of images and different aberrations	
Class-18	Interference of light, young's double slit experiment	
Week-7		
Class-19	Analytical treatment of interference, energy distribution	
Class-20	Interference fringes, interference in thin films	
Class-21	Newton's ring, Interferometer	
MIDTERM		
Week-8		**CT – 2, FINAL**
Class-22	Diffraction : Fresnel & Fraunhofer diffraction, diffraction by single slit	
Class-23	Diffraction by double slit, diffraction gratings	
Class-24	Fraunhofer diffraction at a circular aperture, resolving power of optical instrument	
Week-9		
Class-25	Polarization of light, Brewster's law, Malus' law	
Class-26	Polarization by double refraction, Nicol prism: Polarizer and analyzer	
Class-27	Optical activity: specific rotation, polarimeters	
Week-10		
Class-28	Laser: spontaneous and stimulated emission, applications of laser	
Class-29	Theory of relativity: Frame of reference, postulates of special relativity, Galilean relativity, Galilean transformation	
Class-30	Lorentz transformations, length contraction, time dilation	
Week-11		**CT – 3, FINAL**
Class-31	Velocity addition, relativistic mass and its expression,	
Class-32	Mass and energy equivalence equation and concept of massless particles and its expression, momentum energy relation, problems	
Class-33	Photoelectric effect, photocurrent and work function, kinetic energy, stopping potential	
Week-12		
Class-34	Photoelectric equation, characteristics of photoelectric effect	
Class-35	Compton effect: definition, Compton wavelength shift, limitation	
Class-36	De Broglie concept, condition for wave and particle behavior, Bohr atomic model	
Week-13		
Class-37	Expression for Bohr radii and orbital energy for hydrogen atom	**FINAL**
Class-38	Classification of nuclei, nuclear mass and nuclear binding energy	
Class-39	Radioactivity : Radioactive decay law, half- life	

Week-14		
Class-40	Mean life, nuclear reaction : concept of Fusion, Fission and nuclear chain reaction	
Class-41	General idea on nuclear reactor and nuclear power plant	
Class-42	Review of the syllabus	

ASSESSMENT STRATEGY				
Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1, CO2	C1, C2
	Class Participation	5%		
	Class Attendance	5%		
	Midterm	10%	CO2, CO3	C2, C3
Final Exam		60%	CO 1	C1
			CO 2	C1, C2
			CO 3	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Fundamentals of Physics : Halliday, Resnick and Walker
2. Physics for Scientists and Engineers: Serway and Jewett

REFERENCE BOOKS

1. Physics for Engineers : Part-I and Part-II : Dr Giasuddin Ahmad
2. Physics, Volume I and Volume II : Resnick and Halliday
3. Fundamentals of Physics : Halliday, Resnick and Walker
4. Physics for Scientists and Engineers: Serway and Jewett
5. Waves and Oscillations : Brij Lal and Subramannyam
6. The Physics of Vibrations and Waves: H. J. Pain
7. Concept of Modern Physics: Arthur Beiser
8. University Physics with Modern Physics: Hugh D. Young and Roger A. Freedman
9. Modern Physics for Science and Engineering: Marshall L. Burns
10. Modern Physics : B.L. Theraja
11. Fundamental of Optics: Francis A. Jenkins and Harvey E.White
12. Introduction to Modern Optics: Grant R. Fowles
13. Fundamental Optical Design: Michael J. Kidger
14. A Text Book of Optics : Brijlal and N. Subrahmanyam Fundamental Optical Design: Michael J. Kidger

REFERENCE SITE

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5.1.1.2 MATH 101 Differential and Integral Calculus

COURSE INFORMATION			
Course Code Course Title	: Math 101 : Differential and Integral Calculus	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

Purpose of this course is to introduce basic knowledge of Differential Calculus and use it in engineering study.

OBJECTIVE

1. Be able to impart basic knowledge on differential and Integral Calculus to solve engineering problems and other applied problems.
2. Developing understanding some of the important aspects of rate of change, area, tangent, normal and volume.
3. Be expert in imparting in depth knowledge of functional analysis such as increasing, decreasing, maximum and minimum values of a function

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	**Define** the limit, continuity and differentiability of functions, **identify** the rate of change of a function with respect to independent variables and **describe** the different techniques of evaluating indefinite and definite integrals.	C1-C2	1	1		3	T, F, ASG
CO2	**Apply** the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	C3	1	1		3	T, Midterm Exam, F
CO3	**Calculate** the length, area, volume, center of gravity and average value related to engineering study	C3	1	1		3	Midterm Exam, F, ASG

(C1 – Remember, C2 – Understand, C3 – Apply, C4 – Analyze, C5 – Evaluate, and C6 – Create; CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Differential Calculus: Introduction, Differential Calculus for Engineering, Function and Limit, Continuity and Differentiability, Cartesian differentiation, Successive Differentiation, Leibnittz's Theorem, Rolle's Theorem, Mean Value Theorem, Taylor's theorem, Expansion of Finite and Infinite forms, Indeterminate form, Partial differentiation. Euler's theorem, Tangent, sub tangent and Normal, sub normal, Maxima and Minima, Curvature, Asymptotes,

Integral Calculus: Definition of Integration, Importance of Integration in Eng., Integration by substitution, Integration by parts, Standard integrals, Integration by successive reduction, Definite integrals and its properties, Integration as a limit of sum, summing series, Walli's formula, Improper Integrals, beta and gamma function, multiple integral and its application, Area, volume of solid revolution, Area under a plain curve, Area of the region enclosed by two curves, Arc lengths of curves.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO 1	**Define** the limit, continuity and differentiability of functions, **identify** the rate of change of a function with respect to independent variables and **describe** the different techniques of evaluating indefinite and definite integrals	3											
CO 2	**Apply** the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	3											
CO 3	**Calculate** the length, area, volume, center of gravity and average value related to engineering study	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering has to be applied to describe the complete concept of differential and integral calculus.
CO2-PO1(a)	**3**	To apply proper and improper integral in the field of engineering study, the knowledge of mathematics, science and engineering is required.
CO3-PO1(a)	**3**	In order to calculate volume, average, center of gravity and area of any solid revolution object, the knowledge of mathematics and engineering is needed.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Introduction to Differential Calculus for Engineering study, Limit of a function and its properties.	
Class 2	Basic limit theorems with proofs, Limit of infinity and infinite limit, Sandwich (Squeezing) theorem with problems.	
Class 3	Concept of Differentiation, definition, classification of discontinuity and solving problems	
Week 2		
Class 4	Basic concept of Differentiability, definition, derivative of a function, differentiable function.	
Class 5	Differentiability – one sided derivatives (R.H.D and L.H.D), solving problems	
Class 6	Successive differentiation – Concept and problem solving	
Week 3		
Class 7	Leibnitz's theorem and its applications	
Class 8	Determination of $(y_n)_0$	
Class 9	Mean Value theorem, Taylor theorem	
Week 4		CT 2
Class 10	Expansion of finite and infinite forms, Lagrange's and Cauchy's form of remainder.	
Class 11	Indeterminate forms – concept and problem solving,	
Class 12	L'Hospital's rul s with application	
Week 5		
Class 13	Partial differentiation - partial derivatives of a function of two variables and problems	
Class 14	Partial differentiation - partial derivatives of a homogeneous function of two variables, Euler's theorem for two variables and problems	
Class 15	Partial differentiation - partial derivatives of a homogeneous function of several variables, Euler's theorem for several (three and m) variables and problem solving	
Week 6		
Class 16	Tangents and Normals – Tangents and Normals in Cartesian, equation of tangent at the origin, equation of normal of functions of explicit and implicit forms, Angle between two intersection of two curves; problem solving	
Class 17	Tangents and Normals – Tangents and Normals in polar, Angle between two intersection of two curves; problem solving	
Class 18	Tangents and Normals – Subtangent and subnormals in Cartesian and polar coordinate; problem solving	
Week 7		Mid Term
Class 19	Maxima and minima of functions of single variables – concept, Increasing and decreasing function, Concave up and down with problems	
Class 20	Curvature	
Class 21	Asymptotes	
Week 8		
Class 22	Introduction to integral calculus	
Class 23	Standard integrals – concept of definite and indefinite integrals, applications.	
Class 24	Indefinite integrals – Method of substitution, Techniques of integration	
Week 9		

Class 25	Indefinite integrals – Integration by parts, Special types of integration, integration by partial fraction	
Class 26	Integration by the method of successive reduction	
Class 27	Definite integrals – definite integrals with properties and problems	
Week 10		CT 4
Class 28	Definite integrals – Reduction formula, Walli's formula	
Class 29	Definite integrals – definite integral as the limit of the sum	
Class 30	Beta function – concept and problem solving	
Week 11		
Class 31	Gamma function - concept and problem solving	
Class 32	Relation between beta and gamma function, Legendre duplication formula, problems and applications	
Class 33	Multiple integrals – double integrals	
Week 12		
Class 34	Multiple integrals – triple integrals	
Class 35	Multiple integrals – successive integration for two and three variables	
Class 36	Area in Cartesian	
Week 13		
Class 37	Area in polar	
Class 38	Volume of solid revolution	
Class 39	Area under a plain curve in Cartesian and polar coordinates	
Week 14		
Class 40	Area of a region enclosed by two curves in Cartesian and polar coordinates	
Class 41	Arc lengths of curves in Cartesian coordinates	
Class 42	Arc lengths of curves in polar coordinates	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation	5%	CO 3	C3
	Midterm	15%	CO 2, CO3	C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Calculus (9th Edition) by Howard Anton (Author), Irl C. Bivens (Author), Stephen Davis.

REFERENCE BOOKS

1. Calculus: An Intuitive and Physical Approach By Morris Kline.
REFERENCE SITES
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5.1.1.3 CHEM 103 General Chemistry

COURSE INFORMATION			
Course Code Course Title	: CHEM 103 : General Chemistry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
None			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
To learn the basic concepts of inorganic chemistry, physical chemistry and spectroscopic techniques			
OBJECTIVE			
1. To define the different parameter and concepts of inorganic chemistry. 2. To apply different chemical theory to evaluate structure of molecules. 3. To explain the basic concepts of physical chemistry. 4. To describe basic principles of spectroscopic techniques.			
COURSE OUTCOMES AND GENERIC SKILLS			

No.	Course Outcomes	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **define/identify** the different parameters and fundamental concepts regarding inorganic and physical chemistry, spectroscopic techniques.	1	C1			1	T, F, Mid Term
CO2	Be able to **apply** different theories on chemical bonding and hybridization to determine structure of molecules.	1	C3			1,2	T, F, Mid Term, ASG
CO3	Be able to **explain/illustrate /derive** different theories based on colligative properties, chemical equilibrium, chemical kinetics, thermochemistry and electrochemistry, spectroscopic techniques	1	C2			1,2	T, F, Mid Term, ASG
CO4	**Solve/Analyze** different problems related to inorganic and physical chemistry	2	C4			1,2	ASG ,Mid Term Exam, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Atomic Structure: Concepts of atomic structure, Different atom models, Quantum theory and electronic configurations, Heisenberg's uncertainty principle
Periodic Table: Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases
Chemical Bonding: Types and properties, Lewis theory, VBT, MOT, Hybridization and shapes of molecules
Introduction to spectroscopic techniques: interaction of electromagnetic radiation with matter, IR spectroscopy, UV-Vis spectroscopy, Beer-Lambert law
Fundamentals of chromatography: Basic principle, classification
Acids-Bases/Buffer Solution: Different concepts of acids-bases, Buffer solution, Mechanism of buffer solution, Henderson-Hasselbalch equation, Water chemistry and pH of water. Theories of Acid-Base Indicators.
Solutions: Solutions and their classification, Unit expressing concentration, Colligative properties and dilute solutions, Raoult's law, Van't Hoff's law of osmotic pressure
Thermochemistry: Laws of thermochemistry, Enthalpy, Heat of reaction, Heat of formation, Heat of neutralization, Kirchoff's equations, Hess's law
Electrochemistry: Conductors and nonconductors, Difference between electrolytic and metallic conduction, Electrolytic conductance, Factors influencing the conductivity of electrolytes, Kohlrausch Law and conductometric titrations
Chemical Equilibria: Equilibrium law/constant, K_p and K_c, Homogeneous and heterogeneous equilibrium, Van't Hoff's reaction isotherm, Le Chatelier's principle
Phase Rule: Basic terms and phase rule derivation, Phase diagram of water
Chemical Kinetics: Order and rate of reaction, Pseudo and zero order reaction, Half-life, Determination and factors affecting the rate of a reaction, First order reaction, Second order reaction, Collision theory, Transition state theory

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define/identify** the different parameters and fundamental concepts regarding inorganic and physical chemistry, spectroscopic techniques.	3											
CO2	Be able to **apply** different theories on chemical bonding and hybridization to determine the structure of molecules.	2											
CO3	Be able to **explain/illustrate /derive** different theories based on colligative properties, chemical equilibrium, chemical kinetics, thermochemistry and electrochemistry, spectroscopic techniques	2											
CO4	**Solve/Analyze** different problems related to inorganic and physical chemistry		1										

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATIGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture Class Performance	42 - -

Self-Directed Learning Assignments Revision of the previous lecture at home Preparation for final examination	 42 21 21
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Content	Assessment
Week 1	**General Introduction/Atomic Structure**	**CT**
Class 1	General introduction on the importance of chemistry for BME students, Concepts of atomic structure, Different atom models	**CT-1**
Class 2	Concepts of atomic structure, Different atom models	
Class 3	Quantum numbers, Electronic configuration	
Week 2	**Atomic Structure/Periodic Table**	
Class 4	Hydrogen spectral lines, Heisenberg's uncertainty principle	
Class 5	Classification of elements according to electronic configurations	
Class 6	Periodic classification of elements	
Week 3	**Periodic Table/Chemical Bonding**	
Class 7	Periodic properties of elements, Properties and uses of noble gases	
Class 8	Alkali metals: Chemical properties and uses	
Class 9	Chemical bonding (types, properties, Lewis theory, VBT)	
Week 4	**Chemical Bonding**	**CT-2**
Class 10	Molecular orbital theory (MOT)	
Class 11	Molecular orbital theory (MOT)	
Class 12	Hybridization and shapes of molecules	
Week 5	**Chemical Bonding/ Spectroscopic Techniques**	
Class 13	Hybridization and shapes of molecules	
Class 14	Hybridization and shapes of molecules	
Class 15	Interaction of electromagnetic radiation with matter, IR spectroscopy	
Week 6	**Spectroscopic Techniques**	
Class 16	IR spectroscopy	
Class 17	UV-Vis spectroscopy	
Class 18	UV-Vis spectroscopy, Beer-Lambert law	
Week 7	**Acids-Bases**	**CT-3/Mid Term**
Class 19	Different concepts of acids-bases	
Class 20	Buffer solution, Mechanism of buffer solution	
Class 21	Henderson-Hasselbalch equation, Theories of Acid-Base Indicators	
Week 8	**Acids-Bases/Solutions**	
Class 22	Water chemistry and pH of water	
Class 23	Solutions and their classification, Unit expressing concentration	
Class 24	Effect of temperature and pressure on solubility, Validity and limitations of Henry’s law	

Week 9	**Solutions/Thermochemistry**	
Class 25	Colligative properties and dilute solutions, Raoult's law, deviation from Raoult's law, Elevation of boiling point	
Class 26	Freezing point depression, Van't Hoff's law of osmotic pressure	
Class 27	Laws of thermochemistry, Enthalpy	
Week 10	**Thermochemistry/Electrochemistry**	
Class 28	Heat of reaction, Heat of formation, Heat of neutralization	
Class 29	Hess's law, Kirchoff's equations	
Class 30	Electrolytic conduction and its mechanism	
Week 11	**Electrochemistry**	
Class 31	Faraday's law, Kohlrausch Law, Debye-Huckel-Onsagar theory	
Class 32	Conductrometric titrations	
Class 33	Different types of cells	
Week 12	**Chemical Equilibrium**	
Class 34	Reversible reactions, Characteristics of chemical equilibrium, Law of mass action, Equilibrium constant, Units of equilibrium constant	
Class 35	Relation between K_p and K_c,Van't Hoff's reaction isotherm	**CT-4**
Class 36	Free energy and its significance Heterogeneous equilibrium, Le Chatelier's principle	
Week 13	**Chemical Equilibrium /Phase rule/ Chemical Kinetics**	
Class 37	Temperature dependence on equilibrium constant	
Class 38	Definitions related to phase rule, Phase diagram of water	
Class 39	Rate of reaction, Order of reaction, Molecularity of reaction, Pseudo and zero order reaction,	
Week 14	**Chemical Kinetics**	
Class 40	First order reaction, Second order reaction, Half-life	
Class 41	Determination of order of reaction	
Class 42	Collision theory, Transition state theory	

ASSESSMENT STRATEGY

Components		Grading	CO	Bloom's Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1	C1
			CO2	C3
			CO3	C2
			CO4	C4
	Class Performance	5%	-	-
			-	-
	Mid term	15%	CO1, CO3, CO4	C1, C3, C4, C4
Final Exam		60%	CO1	C1
			CO2	C3,
			CO3	C2
			CO4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Modern Inorganic Chemistry – S. Z. Haider
2. Concise Inorganic Chemistry – J. D. Lee

REFERENCE BOOKS

1. Modern Inorganic Chemistry – S. Z. Haider
2. Analytical Chemistry- G.D. Christian
3. Essentials of Physical Chemistry – Bahl and Tuli
4. Physical Chemistry – Atkins

REFERENCE SITES

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5.1.1.4 CHEM 104 Chemistry Sessional

COURSE INFORMATION			
Course Code Course Title	: CHEM 104 : Chemistry Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
PRE-REQUISITE			
CHEM 103: General Chemistry			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
To learn the basic concepts of inorganic, organic and physical chemistry.			
OBJECTIVE			
1. To familiarize the students with experimentation of acid and base neutralization, titration and quantitative analysis of metals etc. 2. To make students proficient in iodimetric and iodometric analysis and complexometric titration etc. 3. To develop students' ability in estimating zinc, ferrous content in water sample by using various titrimetric methods, and UV-Vis spectrophotometric method.			
COURSE OUTCOMES & GENERIC SKILLS			

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **define** the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on.	C1	1	-	-	1	T, Q, R, ASG
CO2	Be able to **describe** the different phenomena regarding iodimetric and iodometric method, complexometric titration, UV-Vis spectrophotometric method, etc.	C2	1	-	-	1	T, Q, R,ASG
CO3	Be able to **estimate** zinc, ferrous content in water sample by using various titrimetric, spectrophotometric methods and report writing	P3	PO5, PO9	-	-	1	T, Q, R, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Quantitative chemical analysis in the field of inorganic and physical chemistry such as:
Acid-base titration, Redox titration, Iodometric and Iodimetric titration, Complexometric titration.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define** the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on.	3											
CO2	Be able to **describe** the different phenomena regarding iodimetric and iodometric method, complexometric titration, UV-Vis spectrophotometric method, etc.	3											
CO3	Be able to **estimate** zinc, ferrous content in water sample by using various titrimetric, spectrophotometric methods and report writing					3				2			

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Class/ Week	Intended topics to be covered	Remarks
Class 1	Introduction	
Class 2	Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.	
Class 3	Standardization of Hydrochloric Acid (HCl) Solution with standard Sodium Hydroxide (NaOH) Solution.	
Class 4	Standardization of Hydrochloric Acid (HCl) Solution with standard Sodium Carbonate (Na_2CO_3) Solution.	
Class 5	Determination of Calcium (Ca) Content in a calcium chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylene Diamine Tetra Acetic Acid (Na_2-EDTA) Solution.	
Class 6	Standardization of Sodium ThiosulphatePentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.	
Class 7	Estimation of Copper (Cu) Content in a Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$) (Blue Vitriol) Solutions by Iodometric Method with standard Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution.	
Class 8	Standardization of Potassium Permanganate ($KMnO_4$) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.	
Class 9	Determination of Ferrous (Fe) Content in an Ammonium Ferrous Sulphate (Mohr's Salt) [$FeSO_4.(NH_4)_2SO_4.6H_2O$] Solution with Standard Potassium Permanganate ($KMnO_4$) solution.	
Class 10	Spectroscopic determination of iron (II) by complexing with 1,10-phenanthroline	
Class 11	Practice Lab	
Class 12	Lab Test	
Class 13	Quiz Test	
Class 14	Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C1, C2, P3
	Class Participation	20%	CO1, CO2, CO3	C1, C2, P3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C1, C2, P3
	Quiz	30%	CO1, CO2, CO3	C1, C2, P3
	Viva	10%	CO1, CO2, CO3	C1, C2, P3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, Longman Scientific & Technical, 1989

REFERENCE BOOKS

1. G. D. Christian., Analytical Chemistry, 6th Edition, Wiley India Pvt. Limited, 2007
2. A. Jabbar Mian and M. Mahbubul Haque-Practical Chemistry

REFERENCE SITE

5.1.1.5 GES 101 Fundamentals of Sociology

COURSE INFORMATION

Course Code Course Title	: GES 101 : Fundamentals of Sociology	Lecture Contact Hours Credit Hours	: 2.00 : 2.00

PRE-REQUISITE

-

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

-

OBJECTIVE

1. Understanding social phenomena

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basic nature, scope and perspectives of sociology.	C2	1,2,6	-	-	1	T, F
CO2	Be able to **apply** sociological imagination to the context of social problems of BD society	C3	3	-	-	1	T, MID, F
CO3	Be able to **understand** the stages of social research processes and methodologies	C2	6,7	-	-	1	T, F

CO4	Be able to **analyze** different cultures, civilizations and different social problems and design solutions for those	C4	11	-	-	1	T, MID, F
CO5	Be able to **understand and analyze** social stratification, different social systems, socialism, capitalism and relate them to BD society	C2	6,7	-	-	1	T, F
CO6	Be able to **apply** contextual knowledge to assess societal and cultural issues in environmental context for sustainable development	C3	7	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 – Create

COURSE CONTENT

Nature and scope; Sociological imagination, Perspectives of sociology, Stages of social research and research method, Culture and civilization, Socialization and self -development, Globalization and social changes, Media and individual, Social organizations and social problems, social stratification; industrial revolution, Capitalism and socialism, Work and economic life, Environment and human activities, Climate change and global risk, Population and human society, Urbanization and city development, Social changes and technology.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basic nature, scope and perspectives of sociology.	3	3				3						
CO2	Be able to **apply** sociological imagination to the context of social problems of BD society			3									
CO3	Be able to **understand** the stages of social research processes and methodologies						3	3					
CO4	Be able to **analyze** different cultures, civilizations and different social problems and design solutions for those											3	
CO5	Be able to **understand and analyze** social stratification, different social systems, socialism, capitalism and relate them to BD society						3	3					
CO6	Be able to **apply** contextual knowledge to assess societal and cultural issues in environmental context for sustainable development							3					

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning Lecture	28

Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision of the previous and (or) subsequent lecture at home	14
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Weeks	Topics	Assessment
1		**CT – 1 and Midterm, Final**
Lecture 1	Definition, nature and scope of sociology	
Lecture 2	Sociological imagination	
2		
Lecture 3	Perspectives of sociology	
Lecture 4	Orientation of sociological theories	
3		
Lecture 5	Social research and its process	
Lecture 6	Research designs and techniques.	
4		
Lecture 7	Introducing culture and its variations	
Lecture 8	Civilization	
5		**Midterm, Final**
Lecture 9	Defining family and its changes	
Lecture 10	Socialization process and development of self	
6		
Lecture 11	Introducing globalization and its impact on human life	
Lecture 12	Factors responsible to globalization	
7		
Lecture 13	Media and its impact in modern society	
Lecture 14	Addressing social problems of Bangladesh	
MIDTERM		
8		**CT – 2, FINAL**
Lecture 15	Introducing social groups and organizations	
Lecture 16	Introducing bureaucracy and good governance	
9		
Lecture 17	Introducing social stratifications and social inequality	
Lecture 18	Poverty and its types and dimensions	
10		

Lecture 19	Industrial revolution and aftermath	
Lecture 20	Urbanization and city development	
11		**CT – 3, FINAL**
Lecture 21	Capitalism: features and influence	
Lecture 22	Socialism: features and influence	
12		
Lecture 23	Environment and human activities	
Lecture 24	Climate change and global risk	
13		
Lecture 25	Population of Bangladesh: problem or prospect	
Lecture 26	Crime and deviance: a brief analysis	
14		-
Lecture 27	Review 1	
Lecture 28	Review 2	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4, CO5, CO6	C2, C3, C4
	Class Participation	5%	CO3	C2
	Mid term	15%	CO2, CO4	C3, C4
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
			CO 5	C2
			CO 6	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Sociology in Modules: by – Richard Schaefer, 2nd edition, 2013
2. Sociology - Primary Principles: by CN Shankar Rao

REFERENCE BOOKS

1. Anthony Giddens- 5th edition
2. Relevant journal

REFERENCE SITE

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5.1.2 Level-1, Fall

5.1.2.1 PHY 127 Structure of matter, Electricity, Magnetism, and Mechanics

COURSE INFORMATION			
Course Code	: PHY 127	Lecture Contact Hours	: 3.00
Course Title	: Structure of Matter, Electricity, Magnetism and Mechanics	Credit Hours	: 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course is one of the basic physics in the field of structure of matter, electricity and magnetism and mechanics. The course will be emphasized the basic concepts, theories and solve quantitative problems which can be applicable in a wide spectrum of engineering disciplines.

OBJECTIVE

1. To define the different parameter and concepts of structure of matter, electricity and magnetism and mechanics.
2. To explain the basic theories of structure of matter, electricity and magnetism and mechanics.
3. To solve numerical problems regarding structure of matter, electricity and magnetism and mechanics.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome At the end of the course, a student should be able to	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **define** different basic parameters in the field of structure of matter, electricity and magnetism and mechanics such as crystal structure, crystal defects, charge, Coulombs law, flux, momentum, wave function etc.	C1	1	-	-	1	MT, T, F
CO2	Be able to **explain** different basic theories in the field of structure of matter, electricity and magnetism and mechanics such as such as the Bragg's law, bonding energy, electric field, dipole moment, Faraday's law, Schrödinger equation etc	C2	1	-	-	1	MT, T, F
CO3	Be able to **solve** quantitative problems in the field of structure of matter, electricity and magnetism and mechanics such as such as packing factor, Miller indices, electricity, magnetism, classical & quantum mechanics, etc.	C3, C4	1	-	-	2	MT, T, F, ASG

(CP – Complex Problems, CA – Complex Activities, KP – Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, CS – Case study, MT- Mid Term Exam, F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

Structure of matter : States of matter, plasticity and elasticity, crystalline and non-crystalline solids, single crystal and poly-crystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, Miller indices, relation between inter-planar spacing and Miller indices, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns; defects in solids: point defects, line defects, surface defects, bonds in solids, band theory of solids: distinction between metal, semiconductor and insulator, inter-atomic distances, calculation of cohesive and bonding energy.

Electricity and Magnetism : Electric charges and Coulomb's law, quantization of charge, electric field, electric field due to : point charge, dipole, charged rod and charged ring, electric flux and calculation of flux, Gauss' law, application of Gauss' law, electric potential, calculation of electric potential, equipotential surfaces, energy and electric potential, Capacitors, capacitance for different capacitors, energy store in a capacitor, dielectrics and atomic view of dielectrics and Gauss' law with dielectrics, Current density, drift speed, resistances, ohm's law and resistivity-an atomic view, Biot-Savart law and Ampere's law and their applications, Laws of electromagnetic induction, self-inductance and mutual inductance, Magnetic force on a current carrying conductor, Torque on a current carrying loop, Hall effect, solenoid and toroid, Maxwell's equations, Magnetic field intensity, susceptibility, permeability, magnetization; classification of magnetic materials, soft and hard magnetic materials, superparamagnetic materials and their applications.

Mechanics: Linear momentum of a system of particles, conservation of linear momentum, elastic and inelastic, collisions, angular kinematics, torque, rigid bodies, moment of inertia, angular momentum of a system of particles, conservation of angular momentum. Introduction to Quantum Mechanics, wave function, uncertainty principle, postulates of quantum mechanics, Schrödinger time independent and time dependent equation, eigen value, expectation value, probability, particle in a potential box, calculation of energy.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define** different basic parameters in the field of structure of matter, electricity and magnetism and mechanics such as crystal structure, crystal defects, charge, Coulombs law, flux, momentum, wave function etc.	√											
CO2	Be able to **explain** different basic theories in the field of structure of matter, electricity and magnetism and mechanics such as such as the Bragg's law, bonding energy, electric field, dipole moment, Faraday's law, Schrödinger equation etc	√											
CO3	Be able to **solve** quantitative problems in the field of structure of matter, electricity and magnetism and mechanics such as such as packing factor, Miller indices, electricity, magnetism, classical & quantum mechanics, etc.	√											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level of Matching	Justification

CO1-PO1	3	The conceptual knowledge of the natural sciences applicable to the engineering discipline
CO2-PO1	3	The theory-based knowledge of the natural sciences applicable to the engineering discipline
CO3-PO1	3	The numerical analysis based knowledge of the natural sciences applicable to the engineering

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	3
Final Examination	3
Total	132

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1		**CT – 1 and Midterm, Final**
Lecture 1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, assessment of the course.	
Lecture 2	States of matter, classification of solids, plasticity and elasticity, types of crystalline solids, crystal, lattice, basis, crystal structure, plane lattice, space lattice, Bravais and non-Bravais lattices	
Lecture 3	Unit cell, lattice parameters, primitive and non-primitive cells and their distinctions, lattice symbols, crystal structure of NaCl and CsCl	
2		
Lecture 4	Unit face, axial units: linear and numerical parameters and, Miller indices	
Lecture 5	Atomic radius, packing factor and coordination number for different structures	
Lecture 6	Relation between lattice constant and density of solids and related numerical problems.	
3		

Lecture 7	Inter-planer spacing, relation between inter-planar spacing and Miller indices, problems	
Lecture 8	X-ray diffraction, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns, problems	
Lecture 9	Defects in solids: point defects, line defects, surface defects	
4		Midterm, Final
Lecture 10	Defects in solids: point defects, line defects, surface defects	
Lecture 11	Atomic arrangement in solid: different types of bonds in solids	
Lecture 12	Band theory of solids : valence band, conduction band, energy gap, distinction between metal, semiconductor and insulator	
5		
Lecture 13	Potential, cohesive energy, binding energy, Madelung constant, inter-atomic distance, calculation of total potential energy of a pair of atoms	**Midterm, Final**
Lecture 14	Calculation of total potential energy at the equilibrium separation of an ionic crystal, problems	
Lecture 15	Electric charges and Coulomb's law, quantization of charge, electric field, electric field due to : point charge, uniformly charged wire, charged ring, charged disk	
6		
Lecture 16	Electric field due to dipole, dipole in an electric field, electric flux and calculation of flux, Gauss' law	
Lecture 17	Gauss' law and Coulomb's law for a point charge, application of Gauss' law for : charged sphere, line of charge, sheet of chare, parallel charged plates	
Lecture 18	Electric potential, potential and electric field strength, calculation of electric potential : due to a point charge, dipole	
7		
Lecture 19	Calculation of electric potential : charged ring, charged disk, electric potential energy, equipotential surfaces, calculation of electric field from the potential	
Lecture 20	Capacitors, capacitance for different capacitors	
Lecture 21	Energy store in a charged capacitor, energy density, dielectrics and atomic view of dielectrics and Gauss' law with dielectrics	
MIDTERM		
8		
Lecture 22	Concept of electric current, current density, drift velocity, resistances, ohm's law and resistivity-an atomic view,	
Lecture 23	Magnetic force on a current carrying conductor, torque on a current carrying loop, Hall effect	
Lecture 24	Biot-Savart law and Ampere's law and their applications, solenoid and toroid	
9		**CT – 2, FINAL**
Lecture 25	Laws of electromagnetic induction, self-inductance and mutual inductance	
Lecture 26	Maxwell's equations	
Lecture 27	Magnetization; magnetic field intensity, susceptibility, permeability	

10		
Lecture 28	Classification of magnetic materials, magnetization curves, susceptibility curves, M-H hysteresis loop, soft and hard magnetic materials	
Lecture 29	Superparamagnetic materials and their applications	
Lecture 30	Mechanics : classical, quantum and statistical mechanics, centre of mass, centre of gravity	
11		**CT – 3, FINAL**
Lecture 31	Coincidence of centre of mass and centre of gravity, motion of the centre of mass, problems	
Lecture 32	Linear momentum of a particle, linear momentum of a system of particles, conservation of linear momentum	
Lecture 33	Elastic and inelastic, collisions, angular kinematics, torque, rigid bodies	
12	**Mechanics**	
Lecture 34	Moment of inertia of different objects, problems	
Lecture 35	angular momentum of a particle, angular momentum of a system of particles, principle of conservation of angular momentum,	
Lecture 36	Introduction to Quantum Mechanics, wave function, uncertainty principle	
13		**FINAL**
Lecture 37	Fundamental postulates of wave mechanics, wave function, uncertainty principle	
Lecture 38	Time dependent Schrödinger's equation	
Lecture 39	Time independent Schrödinger's equation	
14		
Lecture 40	Eigen value, expectation value, probability	
Lecture 41	Particle in a potential box	
Lecture 42	Calculation of energy	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1, CO3	C1, C2
	Class Attendance	5%		
	Class Participation	5%		A2
	Midterm	10%	CO2, CO3	C1, C2
Final Exam		60%	CO 1	C1
			CO 2	C1, C2, C4
			CO 3	C3, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

REFERENCE BOOKS
1. Physics for Engineers : Part-I and Part-II : Dr Giasuddin Ahmad 2. Physics, Volume I and Volume II : Resnick and Halliday 3. Fundamentals of Physics : Halliday, Resnick and Walker 4. Physics for Scientists and Engineers: Serway and Jewett 5. Introduction to Solid State Physics: Charles Kittle 6. Solid State Physics: S. O. Pillai 7. Solid State Physics: Ali Oma 8. Fundamentals of Solid State Physics : B.S. Saxena, R.C. Gupta, P.N. Saxena 9. B.Sc Physics: C. L. Arora. 10. Concept of Electricity and Magnetism : Rafiqullah, Roy, Huq 11. Electricity and Magnetism : K. K. Tewari 12. Elements of Quantum Mechanics : Kamal Singh, S.P. Singh 13. Concepts of Modern Physics : Arthur Beiser 14. Quantum Mechanics : Gupta, Kumar & Sharma
REFERENCE SITE
-

5.1.2.2 PHY 128 Physics Sessional

COURSE INFORMATION							
Course Code : **PHY 128** Course Title : **Physics Sessional**				Lecture Contact Hours : **3.00** Credit Hours : **1.50**			
PRE-REQUISITE							
N/A							
CURRICULUM STRUCTURE							
Outcome Based Education (OBE)							
SYNOPSIS/RATIONALE							
This course is a laboratory course for the basic physics in the field of waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics. The course will be emphasized the fundamental experiments on different fields of physics which can be applicable in a wide spectrum of engineering disciplines. This laboratory course will enable students to understand basic physics practically as well as do work with team or individual.							
OBJECTIVE							
1. To develop basic physics knowledge practically 2. To practice use of basic scientific instrument.							
LEARNING OUTCOMES & GENERIC SKILLS							
No.	Course Outcomes			CP	CA	KP	

	At the end of the course, a student should be able to	Corresponding POs	Bloom's Taxonomy				Assessment Methods
CO1	Be able to **define** the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C1			K1	R, Q, F
CO2	Be able to **describe** the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C1			K1	R, Q, T, F
CO3	Be able to **construct** Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO9	C2			K2	R, Q, T, F
CO4	Be able to **prepare** a report for an experimental work.	PO10	C2			K2	R

(CP – Complex Problems, CA – Complex Activities, KP – Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, CS – Case study, MT- Mid Term Exam, F – Final Exam)

COURSE CONTENT

Quantitative measurement of different parameters in the field of waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics such as:

Specific resistance of materials, high resistance, resistance of a galvanometer, Electrochemical equivalent (ECE) of copper, comparison of the E.M.F's of two cells, radius of curvature, wavelength of light, focal length of lens, specific rotation of sugar, refractive index of a liquid, thermal conductivity of a bad conductor, temperature co-efficient of resistance, pressure co-efficient of a gas, specific heat of a liquid, acceleration due to gravity, spring constant, rigidity modulus, young's modulus, moment of inertia, conservation of linear momentum, frequency of a tuning fork, surface tension, Planck's constant.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define** the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	3											
CO2	Be able to **describe** the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	3											

CO3	Be able to **construct** Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.									2			
CO4	Be able to **define** the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.										1		

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Level of Matching**	**Justification**
CO1-PO1	3	The conceptual knowledge of the natural sciences applicable to the engineering discipline
CO2-PO1	3	The descriptive knowledge of the natural sciences applicable to the engineering discipline
CO3-PO9	2	Able to do work or complete a task as an individual and as a team
CO4-PO10	1	Capable to write a report on an experimental work

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Experiment	35
Self-Directed Learning	
Preparation of Lab Reports	21
Preparation for the Lab Test	13
Preparation of Quiz	9
Preparation of viva	9
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Final viva	1

Final lab exam	3
Total	**112**

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Weeks	**Topics**	Remarks
Week-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, evaluation system of the course, grouping, visit different section of the laboratory, introduction to different basic equipment	
Week-2	Determination of the specific resistance of a wire using meter bridge / Determination of focal length of a concave lens by auxiliary lens method	Perform any one
Week-3	Determination of high resistance by the method of deflection / Determination of resistance of a galvanometer by half deflection method / Determination of specific heat of a liquid by the method of cooling	Perform any one
Week-4	Determination of ECE of copper by using copper voltameter / Determination of the Young's modulus of bar by bending method. / Determination of the Young's modulus for the material of a wire by Searle's apparatus	Perform any one
Week-5	Determination of the wavelength of sodium light by a spectrometer using a plane diffraction grating/ Determination of the moment of inertia of a Fly-wheel about its axis of rotation	Perform any one
Week-6	Determination of the radius of curvature of a plano-convex lens by Newton's ring method/ Determination of the temperature co-efficient of resistance of the material of a wire using a meter-bridge	Perform any one
Week-7	Determination of the specific rotation of sugar by polarimeter/ Determination of the refractive index of a liquid by plane mirror and pin method using a convex lens	Perform any one
Week-8	Determination of the thermal conductivity of a bad conductor by Lee's method / Verification of the law of conservation of linear momentum / Determination of the surface tension of water by capillary tube method and hence to verify Jurin's law	Perform any one
Week-9	Determination of the value of g acceleration due to gravity by means of a compound pendulum / Comparison of the E.M.F's of two cells by a potentiometer	Perform any one
Week-10	Determination of the spring constant, effective mass and the rigidity modulus of the spring / Determination of the pressure co-efficient of a gas at constant volume by constant volume air thermometer	Perform any one
Week-11	Determination of the Planck's constant using photoelectric effect / Determination of the frequency of a tuning fork by Melde's experiment	Perform any one
Week-12	Viva & lab final experimental exam	
Week-13	Viva & lab final experimental exam	
Week-14	Quiz exam	

ASSESSMENT STRATEGY

	CO	Blooms Taxonomy

Components		Grading		
Continuous Assessment (40%)	Class performance/ Assignment	10%	CO1	C1
	Report Writing/ Assignment	30%	CO1, CO4	C1, C2
Final Exam (60%)	Lab test	30%	CO1, CO2, CO3	C1, C2
	Viva	10%		
	Quiz	20%		
Total Marks		100%		
(CO = Course Outcome, C = Cognitive Domain, A = Affective Domain, P = Psychomotor Domain)				

REFERENCE BOOKS

1. Practical physics for degree students : Dr Giasuddin and Md. Sahabuddin
2. Practical Physics: G. L. Squires
3. B.Sc. Practical Physics: C. L Arora
4. Practical Physics: S.L. Gupta and V. Kumar

5.1.2.3 MATH 105 Vector Analysis, Matrix and Coordinate Geometry

COURSE INFORMATION

Course Code Course Title	: Math 105 : Vector Analysis, Matrix and Coordinate Geometry	Lecture Contact Hours Credit Hours	: 3.00 : 3 .00

PRE-REQUISITE

Course Code: Math 105
Course Title: Vector Analysis, Matrix and Coordinate Geometry

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To teach the students the basic Concepts, Principles and operations of Vector, Matrices and Application of Geometry. The aim of this course is to develop the analytical capability of Vector, Matrices and Geometry. Finally this course is designed to develop a capability of students to solve practical problems.

OBJECTIVE

1. Be able to impart basic knowledge on the Vector Analysis, Matrix and Geometry.
2. Achieving ability to familiarize the students with the working principle of calculating differentiation and integration of vector valued functions in Cartesian, cylindrical and spherical geometry.
3. Be able to provide knowledge on using concept of vector, matrix and Geometry in engineering area and solve other applied problems.
4. Be expert in imparting the depth knowledge on the vector analysis, matrix and co-ordinate geometry.

COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	**Define and identify** the physical explanation of different vector notation, **explain** the basic concept of matrix, 2D and 3D geometry.	C1-C2	1	1		1, 3	T, F
CO2	**Interpret** mathematics, science and engineering such as calculating volume and area of any object in vector field.	C2	1	1		3	T, Mid Term Exam, F
CO3	Be proficient to **analyses** and **demonstrate** the technique in engineering problems which is taught in vector, matrix and Geometry.	C1,C3	1	1,3		3	Mid Term Exam, F, ASG

(C1 – Remember, C2 – Understand, C3 – Apply, C4 – Analyze, C5 – Evaluate, and C6 – Create; CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Vector Analysis: Definition of Vector, Scalars and Vectors, Equality of direction ratios and vectors, Addition and Subtraction of Vectors, Multiplication of vectors by scalars, Position Vector of a point, Scalar and vector products of two vectors and their geometrical interpretation, Triple products and multiple products, Differentiation of vectors, Gradient of scalar functions, Divergence and curl of point functions, physical significance of gradient, divergence and curl, Definition of line, surface and volume integral, Integration of Vectors, Green's, stroke's and Gauss theorem and their application.

Matrix: Definition of Matrix, different types of matrices, Algebra of Matrices, Multiplication of matrices, Transpose and adjoint of a matrix, inverse of a matrix, rank and elementary transformation, solution of linear equation or System of Linear Equation, linear dependence and independence of vectors, quadratic forms, matrix polynomials, determination characteristic roots and vectors, null space and nullity of matrix, characteristic subspace of matrix, Eigen values and Eigen Vectors, Caley-Hamilton theorem.

Coordinate Geometry: Introduction to geometry, Rectangular co-ordinates, Angle between two lines, Transformation of co-ordinates, changes of axes, The plane-angle between two planes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties, circles (tangents, normal, chord of contact, pole and polar), equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points), Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid.

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define and identify** the physical explanation of different vector notation, **explain** the complete concept about matrix, 2D and 3D geometry.	3											
CO2	Be able to **interpret** mathematics, science and engineering such as calculating volume and area of any object in vector field.	3											
CO3	Be proficient to **determine** and **find** the technique to obtain the inverse matrix and **calculate** length, volume and area of objects related to engineering study by using vector, **solve** the system of linear equations using matrix and the problems related to the pair of straight lines, circles, system of circles, parabola, ellipse etc.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics, science and engineering has to be applied to describe the operation of being able to identify the physical explanation of different vector notation, explain the complete concept about matrix, 2D and 3D geometry.
CO2-PO1(a)	**3**	In order to interpret mathematics, science and engineering such as calculating inverse matrix and volume and area of any object in vector field.
CO3-PO1(a)	**3**	In order to construct and calculate the area of objects related to engineering study by using vector, **solve** the system of linear equations using matrix and geometry related problems.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1		CT 1
Class 1	Definition of vector, Scalars and Vectors, Equality of direction ratios and vectors, Addition , Subtraction and multiplication of vectors,	
Class 2	Position vector of a point, Scalar and vector products of two vectors and their geometrical interpretation, Triple products and multiple products,	
Class 3	Linear dependence and independence of vectors, Differentiation of vectors,	
Week 2		
Class 4	Gradient of scalar functions, Divergence and curl of point functions,	
Class 5	Physical significance of gradient, divergence and curl	
Class 6	Physical significance of gradient, divergence and curl	
Week 3		
Class 7	Integration of vectors (line, surface and volume integrals)	
Class 8	Integration of vectors (line, surface and volume integrals)	
Class 9	Integration of vectors (line, surface and volume integrals)	
Week 4		CT 2
Class 10	Green's, Stoke's and Gauss's theorem and their application	
Class 11	Green's, Stoke's and Gauss's theorem and their application	
Class 12	Green's, Stoke's and Gauss's theorem and their application	
Week 5		
Class 13	Definition of Matrix, different types of matrices, Algebra of Matrices, Multiplication of matrices,	
Class 14	Transpose and adjoint of a matrix, inverse of a matrix,	
Class 15	Rank and elementary transformation.	
Week 6		
Class 16	Solution of linear equation or System of Linear Equation,	
Class 17	Solution of linear equation or System of Linear Equation,	
Class 18	Quadratic forms, matrix polynomials, determination characteristic roots and vectors	
Week 7		
Class 19	Null space and nullity of matrix, characteristic subspace of matrix,	
Class 20	Eigen values and Eigen Vectors	
Class 21	Caley-Hamilton theorem - concepts and problems	

Week 8		Mid Term
Class 22	Introduction to geometry, Rectangular co-ordinates, Angle between two lines,	
Class 23	Transformation of co-ordinates, changes of axes,	
Class 24	The plane-angle between two planes, pair of straight lines	
Week 9		
Class 25	Pair of straight lines, general equation of second degree and reduction to its standard forms and properties,	
Class 26	Circles (tangents, normal, chord of contact, pole and polar),	
Class 27	Circles (tangents, normal, chord of contact, pole and polar),	
Week 10		CT 4
Class 28	Equation of conics,	
Class 29	Equation of conics,	
Class 30	Homogeneous equations of second degree,	
Week 11		
Class 31	Angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates,	
Class 32	Pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates,	
Class 33	Pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates,	
Week 12		
Class 34	System of circles (radical axes, coaxial circles, limiting points),	
Class 35	System of circles (radical axes, coaxial circles, limiting points),	
Class 36	Three dimensional co-ordinate system,	
Week 13		
Class 37	Direction cosines, projections,	
Class 38	The plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane).	
Class 39	The plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane).	
Week 14		
Class 40	The straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid)	
Class 41	The straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid)	
Class 42	The straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid)	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3
			CO 2	C3,A6

	Class Participation	5%	CO3	C2,C3
	Mid term	15%	CO 2, CO3	C2,C3
Final Exam		60%	CO 1	C1, C2
			CO 2	C1, C2, C3
			CO 3	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Vector Analysis - Seymour Lipschutz, Dennis Spellman and Murray R. Spiegel, Schaum's outlines.
2. Vector Analysis - M. D. Raisinghania.

REFERENCE BOOKS

1. Elementary Linear algebra - Wiely, Howard Anton and Chris Rorres.
2. A Text Book on Co-ordinate Geometry with Vector Analysis - Rahman & Bhattacharjee.
3. Analytic Geometry -Abdur Rahman.
4. Analytical Solid Geometry- Shanti Narayan.

REFERENCE SITES

-

5.1.2.4 CHEM 125 Physical and Bio-organic Chemistry

COURSE INFORMATION			
Course Code Course Title	: CHEM 125 : Physical and Bio-organic Chemistry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

CHEM 103 – General Chemistry

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course introduces students to the theories and structures of chemicals in thermodynamics and equilibrium, hydrocarbons, and biomolecules. Principles of thermodynamics and free energy, chemical equilibrium, reaction mechanisms and rates, hydrocarbon structures and reactions, structures and mechanisms of sugars, polysaccharides, proteins, and biomolecules are covered in depth.

OBJECTIVE

1. To acquire sufficient knowledge of the concepts and parameters of thermodynamics, entropy, equilibrium, and reaction rates.
2. To analyze reaction rates and chemical equilibrium
3. To describe the structures, synthesis, and reaction mechanisms of various hydrocarbons and organic compounds
4. To be able to explain the chemistry behind different bioconjugate techniques, biomolecules, sugars, proteins, lipids, and biological molecules

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods

CO1	Be able to **understand** concepts of thermodynamics, kinetics, and entropy	C2	1	1	-	1, 2	T, F
CO2	Be able to **apply** the concepts of thermodynamics and kinetics to calculating reaction rates and energy	C3	2	1	-	1, 2	T, F
CO3	Be able to **remember/classify** the structure, reactions, and functions of carbohydrates, proteins and lipids	C1	1	-	-	1	MID, F
CO4	Be able to **understand** bioconjugate techniques, and structure and chemistry of biomolecules found in the body	C2	1	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Thermodynamics and Kinetics: Overview of thermodynamics and kinetics, First law of thermodynamics, second law of thermodynamics and entropy, Free energy, 3rd law of thermodynamics, Gibbs Free energy, equilibrium and free energy, reaction mechanism, Arrhenius equation and catalysis, rates of reaction, Kinetic theory of gases, ideal gas law
Organic chemistry: Chemistry of hydrocarbons, Synthetic methods of common organic compounds, Reaction mechanism of typical organic reactions, Structure determination of organic compounds, alkenes, aromatics, ether, aldehyde, esters, amide, amine.
Biomolecules: Basic chemistry of biomolecules and bio-conjugation techniques. Molecular logic of living system, Biomolecules and cells, Sugars, polysaccharides, lipids-triglycerides, phospholipids, amino acids, amino acid sequences, primary, secondary, tertiary and quaternary structure; classification of proteins, biological membranes, chemistry of antibody, protein synthesis.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** concepts of thermodynamics, kinetics, and entropy	3											
CO2	Be able to **apply** the concepts of thermodynamics and kinetics to calculating reaction rates and energy		3										
CO3	Be able to **remember/classify** the structure, reactions, and functions of carbohydrates, proteins and lipids	3											
CO4	Be able to **understand** bioconjugate techniques, and structure and chemistry of biological molecules found in the body	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21

Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	Course introduction	CT – 1 and Midterm, Final
Lecture 1	Course Introduction	
Lecture 2	Introduction to Thermodynamics and Kinetics: Overview of thermodynamics and kinetics from chemistry I	
Lecture 3	Heat and enthalpy	
2	Thermodynamics and Free Energy, First law of thermodynamics	
Lecture 4	Second law of thermodynamics and entropy, Free energy	
Lecture 5	3rd law of thermodynamics	
Lecture 6	Gibbs Free energy	
3	Equilibrium and Reaction mechanisms	
Lecture 7	Equilibrium and free energy	
Lecture 8	Reaction mechanism	
Lecture 9	Arrhenius equation and catalysis	
4	Rates of reaction and gas law	
Lecture 10	rates of reaction	
Lecture 11	Kinetic theory of gases, ideal gas law	
Lecture 12	Review Class	
5	Chemistry of hydrocarbons	Midterm, Final
Lecture 13	Organic chemistry: Chemistry of hydrocarbons	
Lecture 14	Organic chemistry: Chemistry of hydrocarbons,	
Lecture 15	Synthetic methods of common organic compounds	
6	Reaction mechanisms and structure of organic compounds	
Lecture 16	Reaction mechanism of typical organic reactions	
Lecture 17	Reaction mechanism of typical organic reactions	
Lecture 18	Structure determination of organic compounds, alkenes, aromatics	
7	Structure of organic compounds	
Lecture 19	ether, aldehyde, esters	
Lecture 20	amide, amine	
Lecture 21	Basic chemistry of biomolecules	
MIDTERM		
8	Sugars	CT – 2, FINAL
Lecture 22	Sugars and their types, sugar derivatives and biologically relevant sugars	
Lecture 23	structure and isomerism	
Lecture 24	Reactions of sugars	
9	Polysaccharides	
Lecture 25	polysaccharides and glycosidic bonds, amylose and amylopectin	

Lecture 26	Starch, glycogen, and cellulose	
Lecture 27	heteropolysaccharides	
10	Lipids	
Lecture 28	lipids-triglycerides	
Lecture 29	Phospholipids	
Lecture 30	Lipid membranes and structures	
11	Proteins and their structure	CT – 3, FINAL
Lecture 31	amino acids, amino acid sequences	
Lecture 32	primary, secondary, tertiary and quaternary structure	
Lecture 33	classification of proteins	
12	Chemistry of biological molecules	
Lecture 34	biological membranes	
Lecture 35	chemistry of antibody	
Lecture 36	Protein Synthesis	
13	Bioconjugate techniques	FINAL
Lecture 37	Introduction to bioconjugation techniques	
Lecture 38	EDC-NHS chemistry, Imidoester, Carbodiimide chemistry	
Lecture 39	DCC chemistry, maleimide chemistry	
14	Bioconjugation techniques continued	
Lecture 40	Carbonyl group reactive chemistry, photoreactive chemistry	
Lecture 41	PEGylation and surface modification, protein cross-linkers with implications in biology	
Lecture 42	Review Class	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C2, C3
	Class Participation	5%	CO3	C1
	Mid term	15%	CO1, CO2, CO3	C1, C2, C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C1
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Physical Chemistry P. W. Atkins; Oxford University Press.
2. Essentials of Physical Chemistry- B.S. Bahl & G.D. Tuli; S. Chand and Company Ltd.

REFERENCE BOOKS

1. Lehninger Principles of Biochemistry- 4th Edition, by Albert L. Lehninger, David L. Nelson, and Michael M. Cox.
2. Harper's Illustrated Biochemistry- 28th Edition by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil.
3. Morrison and Boyd, Organic Chemistry, 6th Edition, Prentice Hall, 1998

REFERENCE SITE

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5.1.2.5 LANG 102 Communicative English I

COURSE INFORMATION			
Course Code Course Title	: LANG – 102 : Communicative English I	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course has mainly been designed to improve speaking and oral communication skills of the students. The course includes instructions and experience in speech preparation and speech delivery within various real life situations, formal and informal. Emphasis will be given on various speeches, such as informative, persuasive and interactive. This course will help students progress in real life both personally and professionally. Students will be able to understand class lectures and can comfortably continue the Engineering course, and also to compete in the global job market and increase career skills.

OBJECTIVE

1. To develop the four basics skills of English language, i.e. listening, speaking, reading and writing.
2. To develop students' interpersonal skills engaging them in various group interactions and activities.
3. To improve students' pronunciation in order to improve their level of comprehensibility in both speaking and listening.
4. To give the students exposure to different types of texts in English in order to make them informed using different techniques of reading.
5. To gain an understanding of the underlying writing well-organized paragraphs and also to teach how to edit and revise their own as well as peer's writing.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	**Listen, understand, and learn** the techniques of note taking and answering questions.	C1	1	-	-	-	T, ASG, Pr
CO2	**Understand** and **speak** English quickly and smartly using the techniques learnt in the class.	C2	1	-	-	-	T, ASG, Pr
CO3	**Communicate** effectively within the shortest possible time to present their ideas and opinions.	C2	10	-	-	-	T, ASG, Pr
CO4	**Develop** competency in oral, written communication/presentation	C4	10	-	-	-	T, ASG, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Speaking: Introduction to Language: Introducing basic skills of language.
English for Science and Technology. Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd.
Name, family background, education, experience, any special quality/interest, likings/disliking, etc. Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions.

Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints. Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event. Practicing storytelling, Narrating personal experiences/Anecdotes. Telephone conversations (role play in group or pair). Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation).

Listening: Listening and understanding: Listening, note taking and answering questions;
Students will listen to recorded text, note down important information and later on will answer to some questions.
Difference between different accents: British and American accents;
Documentaries from BBC and CNN will be shown and students will try to understand. Listening to short conversations between two persons/more than two.

Reading: Reading techniques: scanning, skimming, predicting, inference; Reading Techniques: analysis, summarizing and interpretation of texts.

Writing: Introductory discussion on writing, prewriting, drafting; Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event; Paragraph writing, Compare-contrast and cause- effect paragraph.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Listen, understand, and learn** the techniques of note taking and answering questions.	3											
CO2	**Understand** and **speak** English quickly and smartly using the techniques learnt in the class.	3											
CO3	**Communicate** effectively within the shortest possible time to present their ideas and opinions.										3		
CO4	**Develop** competency in oral, written communication/presentation										3		

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method
COURSE SCHEDULE

Week	Topic	Assessment
1		**Test, Assignment, Presentation**
Lecture 1	Introduction to Language: Introducing basic skills of language. English for Science and Technology	
Lecture 2	Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd. Name, family background, education, experience, any special quality/interest, likings/disliking, etc.	
Lecture 3	Self-introduction and introducing others: How a speaker should introduce himself to any stranger / unknown person / a crowd. Name, family background, education, experience, any special quality/interest, likings/disliking, etc.	
2		
Lecture 4	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
Lecture 5	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
Lecture 6	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
3		
Lecture 7	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
Lecture 8	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
Lecture 9	Discussing everyday routines and habits, Making requests/offers/invitations/excuses/apologies/complaints	
4		
Lecture 10	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
Lecture 11	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
Lecture 12	Describing personality, discussing and making plans(for a holiday or an outing to the cinema), Describing pictures / any incident / event	
5		
Lecture 13	Practicing storytelling, Narrating personal experiences/Anecdotes	
Lecture 14	Practicing storytelling, Narrating personal experiences/Anecdotes	
Lecture 15	Practicing storytelling, Narrating personal experiences/Anecdotes	

6		
Lecture 16	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
Lecture 17	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
Lecture 18	Telephone conversations (role play in group or pair) Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
7		
Lecture 19	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
Lecture 20	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
Lecture 21	Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions	
Midterm Break		
8		**Test, Assignment, Presentation**
Lecture 22	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
Lecture 23	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
Lecture 24	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
9		
Lecture 25	Listening to short conversations between two persons/more than two	
Lecture 26	Listening to short conversations between two persons/more than two	
Lecture 27	Listening to short conversations between two persons/more than two	
10		
Lecture 28	Reading techniques: scanning, skimming, predicting, inference;	

Lecture 29	Reading techniques: scanning, skimming, predicting, inference;	
Lecture 30	Reading techniques: scanning, skimming, predicting, inference	
11		
Lecture 31	Reading Techniques: analysis, summarizing and interpretation of texts	
Lecture 32	Reading Techniques: analysis, summarizing and interpretation of texts	
Lecture 33	Reading Techniques: analysis, summarizing and interpretation of texts	
12		
Lecture 34	Introductory discussion on writing, prewriting, drafting;	
Lecture 35	Introductory discussion on writing, prewriting, drafting;	
Lecture 36	Introductory discussion on writing, prewriting, drafting	
13		
Lecture 37	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
Lecture 38	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
Lecture 39	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
14		
Lecture 40	Paragraph writing, Compare-contrast and cause- effect paragraph	
Lecture 41	Paragraph writing, Compare-contrast and cause- effect paragraph	
Lecture 42	Paragraph writing, Compare-contrast and cause- effect paragraph	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Listening Test	15%	CO1, CO2, CO3, CO4	C1, C2, C4
	Descriptive writing	25%	CO1, CO2, CO3, CO4	C1, C2, C4
	Public Speaking	30%	CO1, CO2, CO3, CO4	C1, C2, C4
	Presentation	30%	CO1, CO2, CO3, CO4	C1, C2, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Langan, J. (2005). College Writing Skills with Readings (6^{th} Ed). McGraw-Hill Publication
2. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication

REFERENCE BOOKS

1. Jones, L. (1981). Functions of English. (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.
2. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation)
3. From Paragraph to Essay - Maurice Imhoof and Herman Hudson
4. Headway Series – Advanced Level (2 parts with CDs): Oxford University Press Ltd.
5. Speak like Churchill stand like Lincoln - James C. Humes
6. Cambridge IELTS Practice Book
7. Selected Sample Reports and Selected Research Articles

REFERENCE SITE

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5.1.2.6 GEBS 101 Bangladesh Studies

COURSE INFORMATION

Course Code	: GEBS 101	Lecture Contact Hours	: 2.00
Course Title	: Bangladesh Studies	Credit Hours	: 2.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course has been designed for undergraduate engineering students to help them learn the rich history of Bangladesh, and to provide them with basic knowledge of historical events which eventually led to the formation of Bangladesh and constitution of Bangladesh, current trends in economic development, legislation, citizen charter, cultural aspects which will make them responsible citizen.

OBJECTIVE

1. To equip students with factual knowledge that will enable them to learn the history of Bangladesh.
2. To trace the historical roots of Bangladesh as an independent state focusing on the social, cultural and economic developments that have taken place since its independence.
3. To promote an understanding of the development of Bangladesh and its culture.
4. To create an awareness among the students about the Geography, Economy, Politics and Culture of Bangladesh.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and variety of cultural identities of Bangladesh.	C1	6	-	-	-	T, MID, F
CO2	Be able to **explain** the economy and patterns of economic changes through qualitative and quantitative analysis.	C2	6	-	-	-	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 – Create

COURSE CONTENT

Bangladesh Geography: Location, Area, Boundary, Physiography, River system, Forest and Climate,Demography of Bangladesh, Maritime zones.
History: Overview of the ancient Bengal; anthropological identity of the Bengali race; main trends in the history of medieval Bengal; Bengal under the East India Company; religious and social reform movements; nationalist movements, division of the Indian sub-continent; language movement 1948-1952; education movement of 1962; six-point movement of 1966; mass uprising of 1969; war of independence and emergence of Bangladesh in 1971, Constitution of Bangladesh, Pre and post liberation development in the field of engineering and technology, Bangladesh's contribution to world peace and its security, engineering developments in Bangladesh (Kaptai Dam, Padma bridge, power plants, Karnaphuli River Tunnel etc) and its impact on socio-economic aspect .
Environment, Economy and Culture
Land, Characteristics of tropical monsoon climate, Forests and biomass, Fish, Minerals, Health,Education, Agriculture, Industries, NGOs, Population,Sociological and Cultural aspects of Bangladesh, Economy and National development, Development and Progress of the Millennium Development Goals (MDGs), Public Administration in Bangladesh, State of Good Governance in Bangladesh, Artand Literature, Main traditional cultural events, Vision-2021, Digitalization, Tourism and Natural Resources, Bangladesh and International Relations.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and variety of cultural identities of Bangladesh.						3						
CO2	Be able to **explain** the economy and patterns of economic changes through qualitative and quantitative analysis.						3						

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision of the previous and (or) subsequent lecture at home	14
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Weeks	Topics	Assessment
1		CT – 1 and Midterm, Final
Lecture 1	Definition, nature and scope of sociology	
Lecture 2	Sociological imagination	
2		
Lecture 3	Perspectives of sociology	
Lecture 4	Orientation of sociological theories	
3		
Lecture 5	Social research and its process	
Lecture 6	Research designs and techniques.	
4		
Lecture 7	Introducing culture and its variations	
Lecture 8	Civilization	
5		Midterm, Final
Lecture 9	Defining family and its changes	
Lecture 10	Socialization process and development of self	
6		
Lecture 11	Introducing globalization and its impact on human life	
Lecture 12	Factors responsible to globalization	
7		
Lecture 13	Media and its impact in modern society	
Lecture 14	Addressing social problems of Bangladesh	
MIDTERM		
8		CT – 2, FINAL
Lecture 15	Introducing social groups and organizations	
Lecture 16	Introducing bureaucracy and good governance	
9		
Lecture 17	Introducing social stratifications and social inequality	
Lecture 18	Poverty and its types and dimensions	
10		
Lecture 19	Industrial revolution and aftermath	
Lecture 20	Urbanization and city development	
11		CT – 3, FINAL
Lecture 21	Capitalism: features and influence	
Lecture 22	Socialism: features and influence	
12		
Lecture 23	Environment and human activities	
Lecture 24	Climate change and global risk	
13		
Lecture 25	Population of Bangladesh: problem or prospect	
Lecture 26	Crime and deviance: a brief analysis	
14		-
Lecture 27	Review 1	
Lecture 28	Review 2	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
	Class Participation	5%	CO2	C2
	Mid term	15%	CO1	C1
Final Exam		60%	CO 1	C1
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Bangladesh Studies: Md. Shamsul Kabir Khan and Daulatunnahar Khanam
2. The Constitution of the People's Republic of Bangladesh

REFERENCE BOOKS

1. Discovery of Bangladesh: Akbar Ali Khan
2. History of Bangladesh, Vols, 1-3: Sirajul Islam
3. History of Modern Bengal, Vol, 1:R C Majumdar
4. Dynastic History of Bengal: Dr. Abdul MuminChowdhury
5. A History of Bangladesh: William Van Schendel
6. Geography of Bangladesh: HarunEr Rashid
7. Banglapedia: National Encyclopedia of Bangladesh, Vols, 1-10: Sirajul Islam
8. History of Bengal: (Mughal Period 1526-1765): R. A. Chandra
9. Land of Two Rivers: NiteshSengupta
10. A History of Bangladesh: Cambridge University Press
11. Bengali Nationalism and the Emergence of Bangladesh : A.F Salahuddin Ahmed
12. Language Movement and The Making of Bangladesh: Safar Ali Akanda

REFERENCE SITE

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5.1.3 Level-2, Spring

5.1.3.1 MATH 205 Differential Equation, Laplace transform and Fourier Transform

COURSE INFORMATION			
Course Code Course Title	: Math 205 : Differential Equations, Laplace Transform and Fourier Transform	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
-			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
To teach the students the basic Concepts, Principles and operations of Differential Equation, Laplace Transform and Application of Fourier Analysis in Engineering problem. The aim of this course is to develop the analytical and practical capability of Differential equation, Laplace Transform and Fourier Analysis.			
OBJECTIVE			
1. To provide a physical interpretation of the Differential Equations and Laplace Transform. 2. Able to explain the characteristics of Ordinary Differential Equations and Laplace Transform. 3. To apply Laplace and Fourier Transform in solving complex problems. 4. To use differential operations for simplification of complexengineering expressions			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	**Identify** differential equations of various types and **recognize** the basic properties of Laplace and Fourier transform.	C1, C2	1	1		1, 3	T, F
CO2	**Interpret** the classifications of differential equations and **estimate** the technique of Laplace transform and Fourier transform of some elementary function.	C2, C4	1	1		3	T, Mid Term Exam, F
CO3	**Solve** different types of differential equations and **apply** Laplace transform to Ordinary Differential Equation and Fourier as well as Inverse Fourier transform to make use of boundary value problems in Engineering fields	C4	1	1,3		3	Mid Term Exam, F, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Differential Equations (DE): Introduction to DE, Formulation of DE, Degree and order of Ordinary Differential Equation(ODE), Solution of first order DE by various methods, Solution of first order but higher degree DE, Solution of general LEs of second and higher order , Solution of Euler's homogeneous linear DEs , Solution of DEs by methods based on factorization, Application of ODE, Frobenious methods, Bessel's functions, Legendre's polynomial, Power series solution of DE and their application, Integral form of DE and its application to engineering problem, Formation of partial differential equations, Linear and Non-linear first order Partial Differential Equation(PDE), Standard form Linear Equations (LE) of higher order, Linear PDE with constant coefficients. Equation of second order with variable coefficients, wave equation, particular solutions with boundary and initial condition, Integral surface passing through given curve, Second order PDE and classification to canonical solution, Applications of PDE.

Laplace Transform (LT): Definition and properties of Laplace transform, Sufficient conditions for existence of Laplace transforms, Laplace transform of some basic functions, LT of derivatives, Unit step function, Periodic function, Some special theorems on LT, Inverse Laplace transform, Partial fraction, Heaviside expansion formula, Convolution theorem, Evaluation of improper integral, Solution of Differential Equations by LT, Application of LT.

Fourier Transform: Real and Complex form of Fourier Series, Definition and expansion of a function of x in a Fourier Series, Physical application of Fourier Series, Finite Fourier Transform, Fourier Integral, Inverse Fourier transform, Fourier transform and their uses in solving boundary value problems, Diffusion, wave, Laplace Equation

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify** differential equations of various types and **recognize** the basic properties of Laplace and Fourier transform.	3											
CO2	**Interpret** the classifications of differential equations and **estimate** the technique of Laplace transform and Fourier transform of some elementary function.	3											
CO3	**Solve** different types of differential equations and **apply** Laplace transform to DE and Fourier and inverse Fourier transform to make use of boundary value problems in Engineering fields.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	

Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Differential Equations**	**CT – 1, Final**
Lecture 1	Introduction to DE, Formulation of DE, Degree and order of ODE	
Lecture 2	Solution of first order DE by various methods	
Lecture 3	Solution of first order DE by various methods	
2		
Lecture 4	Solution of first order DE by various methods,	
Lecture 5	Solution of first order but higher degree DE, solution of general LEs of second and higher order	
Lecture 6	Solution of Euler's homogeneous linear DEs	
3		
Lecture 7	Solution of DEs by methods based on factorization,	
Lecture 8	Frobenious methods – concept	
Lecture 9	Frobenious methods – problems	
4		**Midterm, Final**
Lecture 10	Solution of differential equations of the higher order when dependent and independent variables are absent	
Lecture 11	Bessel's functions, Legendre's polynomial, Power series solution of DE and their application,	
Lecture 12	Integral form of DE and its application to engineering problem,	
5		
Lecture 13	Formation of partial differential equations, linear and non linear first order PDE,	
Lecture 14	Standard form LEs of higher order	
Lecture 15	Integral surface passing through given curve	
6		
Lecture 16	Non-linear PDE of order one, Charpit's method.	
Lecture 17	Linear PDE with constant coefficients	
Lecture 18	Linear PDE with constant coefficients	
7		

Lecture 19	Equation of second order with variable coefficients, Second order PDE and classification to canonical solution	
Lecture 20	wave equation, particular solutions with boundary and initial condition	
Lecture 21	Application of ODE, Applications of PDE	
Midterm Break		
8	**Laplace Transform**	**CT – 2, Final**
Lecture 22	Definition and properties of Laplace transform	
Lecture 23	Sufficient conditions for existence of Laplace transforms	
Lecture 24	Laplace transform of some basic functions, LT of derivatives	
9		
Lecture 25	Unit step function, Periodic function	
Lecture 26	Some special theorems on LT	
Lecture 27	Inverse Laplace transform	
10		
Lecture 28	Partial fraction,	
Lecture 29	Heaviside expansion formula	
Lecture 30	Convolution theorem	
11		**CT – 3, FINAL**
Lecture 31	Evaluation of improper integral,	
Lecture 32	Solution of Differential Equations by LT	
Lecture 33	Application of LT	
12	**Fourier Transform**	
Lecture 34	Real and Complex form of Fourier Series	
Lecture 35	Definition and expansion of a function of x in a Fourier Series	
Lecture 36	Physical application of Fourier Series	
13		**FINAL**
Lecture 37	Finite Fourier Transform	
Lecture 38	Fourier Integral	
Lecture 39	Inverse fourier transform	
14		
Lecture 40	Fourier transform and their uses in solving boundary value problems	
Lecture 41	Fourier transform and their uses in solving boundary value problems	
Lecture 42	Diffusion, wave, Laplace Equation	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
	Class Participation	5%	CO3	C4
	Mid term	15%	CO2, CO3	C2, C4
Final Exam		60%	CO 1	C1, C2
			CO 2	C2, C4
			CO 3	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Ordinary and Partial Differential Equations by M.D.RAISINGHANIA.
2. Differential Equations by Shepley L. Ross.

REFERENCE BOOKS

1. Differential Equations by Glen R. Hall.
2. Theory and problems of Laplace Transform, Schaum's outlines series, Murray R. Spiegel.

REFERENCE SITE

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5.1.3.2 GELM 271 Leadership and Management

COURSE INFORMATION

Course Code	: GELM 271	Lecture Contact Hours	: 2.00
Course Title	: Leadership and Management	Credit Hours	: 2.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course is designed to make students understand the overlapping connection between engineering and management in an organization through the study of varied management practices and leadership traits as an engineer.

OBJECTIVE

1. To introduce different management functions and approaches.
2. To expose students to different views and styles of leadership
3. To understand how an organization functions collaboratively with managers and engineers.
4. To understand various personality traits and its impact on leadership and management.
5. To solve real-world management problems as an engineer.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **familiarize** with the fundamental concepts of leadership and management skills	C1	9,10	-	-	1	T, R, F

CO2	Be able to **understand** the role and contribution of a leader in achieving organizational goals	C2	9,10	-	-	1	T, ASG, R, F
CO3	Be able to **understand** the contribution of leadership traits and management skills in decision making and solving real life problems	C2	9,10	-	-	1	T, ASG, R, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 – Create

COURSE CONTENT

Introduction to Leadership and Management: Definition of leadership and management; basic difference between a leader and a manager; relation of leaders and managers with respect to efficiency and effectiveness; qualities of leader and managers with examples from history.

Management Fundamentals: Definition of management & manager; levels of management; management functions and skills; Mintzberg's managerial roles; Henri Fayol's management principles; strategic management.

Leadership & Motivation: Motivation, Maslow's hierarchy needs; theory of X & Y; motivators and hygiene factors; goal setting theory; reinforcement theory; equity theory; expectancy theory; Leadership styles; leadership trait theory; managerial grid; contemporary leadership; conflicts negotiation; leadership issues in 21st century; cross cultural leadership; engineer as a leader and some simple case discussions on leadership (positive and toxic leadership) in the class (Interactive Learning).

Organizational Management: Organization; departmentalization; chain of command; unity of command; cross functional area; authority; centralization and decentralization; traditional & contemporary organization; matrix project structure; learning structure; organizing collaboration.

Planning and goal setting: Foundation of planning; goals of plan; types of goal; types of goal & plan; goal setting; MBO; well written goal.

Control: Controlling process; controlling for organizational performance; types of control: (feed-forward, feedback & concurrent); balanced scorecard; contemporary issues in control; workplace concern & workplace violence.

Change and Innovation: Change and innovation; internal and external for change; changing process; creativity vs innovation.

Attitude: Components of Attitude; behavior model and characteristics model; behavior vs. attitude; job attitude; job involvement; job satisfaction and customer satisfaction.

Personality: Personality determinants: heredity and environment; Myers-Briggs Type Indicator; Big five personality model; personality traits (core self-evaluation, Machiavellianism, narcissism, self-monitoring, risk taking, proactive personality).

Perception and Individual Decision Making: Factors influencing perception; attribution theory; errors/biases in attribution; Factors of individual decision making; rational decision making; bounded rationality; satisfice; common errors in decision making; creativity in decision making.

Understanding Work Team: Work group; work team; problem solving team; self-managed work team; cross functional team; virtual team; team effectiveness; team challenges.

HR Management: Process of Human Resource Planning; forecasting demand for labor; staffing; internal supply of labor; performance appraisal.

Operations Management: Project managing basics; goals and boundary of project; WBS; scheduling a project; Demand and supply forecasting; inventory control.

Information Technology and Management: Management Information System (MIS); Enterprise Resource Planning (ERP) - For introductory knowledge.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **familiarize** with the fundamental concepts of leadership and management skills									3	3		
CO2	Be able to **understand** the role and contribution of a leader in achieving organizational goals									3	3		
CO3	Be able to **understand** the contribution of leadership traits and management skills in decision making and solving real life problems									3	3		

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision of the previous and (or) subsequent lecture at home	14
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Weeks	**Topics**	**Assessment**
1		
Lecture 1	**Introduction to Leadership and Management:** Definition of leadership and management; basic difference between a leader and a manager; relation of leaders and managers with respect to efficiency and effectiveness; qualities of leader and managers with examples from history.	**CT – 1 and Midterm, Final**
Lecture 2	**Management Fundamentals:** Definition of management & manager; levels of management; management functions and skills; Mintzberg's managerial roles; Henri Fayol's management principles; strategic management.	
2		
Lecture 3	**Leadership & Motivation**: Motivation, Maslow's hierarchy needs; theory of X & Y; motivators and hygiene factors; goal setting theory; reinforcement theory; equity theory; expectancy theory	

Lecture 4	**Leadership & Motivation**: Motivation, Maslow's hierarchy needs; theory of X & Y; motivators and hygiene factors; goal setting theory; reinforcement theory; equity theory; expectancy theory	
3		
Lecture 5	**Leadership:** Leadership styles; leadership trait theory; managerial grid; contemporary leadership; conflicts negotiation; leadership issues in 21st century; cross cultural leadership; engineer as a leader and some simple case discussions on leadership (positive and toxic leadership) in the class (Interactive Learning).	
Lecture 6	**Leadership:** Leadership styles; leadership trait theory; managerial grid; contemporary leadership; conflicts negotiation; leadership issues in 21st century; cross cultural leadership; engineer as a leader and some simple case discussions on leadership (positive and toxic leadership) in the class (Interactive Learning).	
4		
Lecture 7	**Case Study – I : Engineer as Great Leaders**	
Lecture 8	**Case Study – I : Engineer as Great Leaders**	
5		**Midterm, Final**
Lecture 9	**Organizational Management:**Organization; departmentalization; chain of command; unity of command; cross functional area; authority; centralization and decentralization; traditional & contemporary organization; matrix project structure; learning structure; organizing collaboration.	
Lecture 10	**Planning and goal setting:**Foundation of planning; goals of plan; types of goal; types of goal & plan; goal setting; MBO; well written goal.	
6		
Lecture 11	**Control:** Controlling process; controlling for organizational performance; types of control: (feed-forward, feedback & concurrent); balanced scorecard; contemporary issues in control; workplace concern & workplace violence.	
Lecture 12	**Change and Innovation:** Change and innovation; internal and external for change; changing process; creativity vs innovation.	
7		
Lecture 13	**Case Study – II : Planning and Goal Setting; A Managerial Approach: Engineer as Great Managers (Interactive Discussions in the Class)**	
Lecture 14	**Attitude:** Components of Attitude;behavior model and characteristics model;behavior vs. attitude; job attitude; job involvement; job satisfaction and customer satisfaction.	
MIDTERM		
8		**CT – 2, FINAL**
Lecture 15	**Personality:**Personality determinants: heredity and environment; Myers-Briggs Type Indicator; Big five personality model; personality traits (core self-evaluation, Machiavellianism, narcissism, self-monitoring, risk taking, proactive personality).	
Lecture 16	**Perception and Individual Decision Making**:Factors influencing perception; attribution theory; errors/biases in attribution	
9		

Lecture 17	**Perception and Individual Decision Making**:Factors of individual decision making; rational decision making; bounded rationality; satisfice; common errors in decision making; creativity in decision making.	
Lecture 18	**Case Study – III : A Case on Decision Making – Involves both leadership and managerial skills (Interactive Discussion in the Class)**	
10		
Lecture 19	**Understanding Work Team:** Work group; work team;problem solving team; self-managed work team; cross functional team; virtual team; team effectiveness; team challenges.	
Lecture 20	**HR Management:**Process of Human Resource Planning; forecasting demand for labor; staffing.	
11		**CT – 3, FINAL**
Lecture 21	**HR Management:** Internal supply of labor; performance appraisal.	
Lecture 22	**Operations Management:**Project managing basics; goals and boundary of project; WBS; scheduling a project.	
12		
Lecture 23	**Operations Management:**Demand and supply forecasting; inventory control.	
Lecture 24	**Exercise – Use of Microsoft Project (MSP) for scheduling a project at student level**	
13		
Lecture 25	**Case Study – IV:** A case that covers all relevant theories taught throughout the course and involves both leadership and management issues, e.g., Columbia's Final Mission. (This may be given as group assignment followed by in class short presentations/discussions)	
Lecture 26	**Case Study – IV:** A case that covers all relevant theories taught throughout the course and involves both leadership and management issues, e.g., Columbia's Final Mission. (This may be given as group assignment followed by in class short presentations/discussions)	
14		**-**
Lecture 27	**Information Technology and Management:** Management Information System (MIS); Enterprise Resource Planning (ERP) - For introductory knowledge.	
Lecture 28	**Revision**	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, P1
	Class Participation	5%	CO1, CO2	C1, C2, P1, P2, A1
	Mid term	15%	CO1, CO2, CO3	C1, C2, P1, P2, A1, A2
Final Exam		60%	CO 1	C1, C2, P1, P2, A1, A2
			CO 2	C1, C2, P1, A1
			CO 3	C1, C2, P1, P2, A1, A2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Engineering Management (Revised Edition) – A.K. Gupta
2. Industrial Engineering and Production Management - Martand T. Telsang

REFERENCE BOOKS

3. Leadership in Organizations – Gary Yukl
4. Developing Management Skills – David A. Whetten and Kim S. Cameron

REFERENCE SITE

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5.1.3.3 LANG 202 Communicative English II

COURSE INFORMATION

Course Code	: LANG 202	Lecture Contact Hours	: 3.00
Course Title	: Communicative English - II	Credit Hours	: 1.50

PRE-REQUISITE

LANG 102: Communicative English Sessional –1

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The English language course is designed for the students to develop their competence in communication skills for academic purposes especially in reading and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to different types of texts to develop efficient reading skill. Reading will also involve activities and discussions leading to effective writing. The course incorporates a wide range of reading texts to develop students' critical thinking which is one of the most essential elements required to write a good piece of academic writing. Emphasis is particularly put on the various forms of essay writing such as descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, students are expected to be able to communicate at various situations, participate in group activities and prepare formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. In addition, the course emphasizes on providing constructive feedback on students' oral performances.

OBJECTIVE

1. To develop English language skills to communicate effectively and professionally.
2. To strengthen students' presentation skills.
3. To develop competency in academic reading and writing.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the techniques of academic reading and become acquainted with technical vocabularies	C1	1	-	-	-	T, ASG, Pr
CO2	Be able to **understand** the techniques of effective academic writing such as research article/report writing	C2	1	-	-	-	T, ASG, Pr
CO3	Be able to **communicate effectively** within the shortest possible time to present any report and research work	C2	10	-	-	-	T, ASG, Pr
CO4	Be able to **analyze** any problem critically, analyze and interpret data and synthesize information to provide valid conclusions	C4	10	-	-	-	T, ASG, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Speaking: Reading Comprehension: Practice using different techniques; Academic reading: comprehension from departmental or subject related passages; Vocabulary for Engineers (some common Engineering terms for both general and dept specific); Reading subject specific text to develop vocabulary.

Writing: Writing semi-formal, Formal/official letters, Official E-mail; Applying for a job: Writing Cover Letter and Curriculum Vitae; Statement of Purpose (SOP) writing, Proposal Writing: writing steps, principles and techniques, outlining, revising, editing, proofreading; Report writing, article writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing; Analyzing and describing graphs or charts; Practicing analytical and argumentative writing.

Speaking: Public Speaking: Basic elements and qualities of a good public speaker; Set Speech: How to get ready for any speech. Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.

Listening: Listening to long lecture on some topics, Listening and understanding speeches/lectures of different accent.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the techniques of academic reading and become acquainted with technical vocabularies	3											
CO2	Be able to **understand** the techniques of effective academic writing such as research article/report writing	3											
CO3	Be able to **communicate effectively** within the shortest possible time to present any report and research work										3		
CO4	Be able to **analyze** any problem critically, analyze and interpret data and synthesize information to provide valid conclusions										3		

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1		**Test, Assignment, Presentation**
Lecture 1	Reading Comprehension: Practice using different techniques	
Lecture 2	Reading Comprehension: Practice using different techniques	
Lecture 3	Reading Comprehension: Practice using different techniques	
2		
Lecture 4	Academic reading: comprehension from departmental or subject related passages	
Lecture 5	Academic reading: comprehension from departmental or subject related passages	
Lecture 6	Academic reading: comprehension from departmental or subject related passages	
3		
Lecture 7	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
Lecture 8	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
Lecture 9	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
4		
Lecture 10	Writing semi-formal, Formal/official letters, Official E-mail	
Lecture 11	Writing semi-formal, Formal/official letters, Official E-mail	
Lecture 12	Writing semi-formal, Formal/official letters, Official E-mail	
5		
Lecture 13	Applying for a job: Writing Cover Letter and Curriculum Vitae	
Lecture 14	Applying for a job: Writing Cover Letter and Curriculum Vitae	
Lecture 15	Applying for a job: Writing Cover Letter and Curriculum Vitae	
6		

Lecture 16	Statement of Purpose (SOP) writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
Lecture 17	Proposal writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
Lecture 18	Proposal writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
7		
Lecture 19	Report writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
Lecture 20	Report writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
Lecture 21	Report writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
8		**Test, Assignment, Presentation**
Lecture 22	Analyzing and describing graphs or charts	
Lecture 23	Analyzing and describing graphs or charts	
Lecture 24	Analyzing and describing graphs or charts	
9		
Lecture 25	Practicing analytical and argumentative writing	
Lecture 26	Practicing analytical and argumentative writing	
Lecture 27	Practicing analytical and argumentative writing	
10		
Lecture 28	Public Speaking: Basic elements and qualities of a good public speaker	
Lecture 29	Public Speaking: Basic elements and qualities of a good public speaker	
Lecture 30	Public Speaking: Basic elements and qualities of a good public speaker	
11		
Lecture 31	Set Speech: How to get ready for any speech.	
Lecture 32	Set Speech: How to get ready for any speech.	
Lecture 33	Set Speech: How to get ready for any speech.	
12		
Lecture 34	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
Lecture 35	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
Lecture 36	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.	
13		
Lecture 37	Listening to long lecture on some topics	
Lecture 38	Listening to long lecture on some topics	
Lecture 39	Listening to long lecture on some topics	

14		
Lecture 40	Listening and understanding speeches/lectures of different accents	
Lecture 41	Listening and understanding speeches/lectures of different accents	
Lecture 42	Listening and understanding speeches/lectures of different accents	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Testing vocabulary level	20%	CO1, CO2, CO3, CO4	C1, C2, C4
	Argumentative/analytical writing	25%	CO1, CO2, CO3, CO4	C1, C2, C4
	Individual Presentation	25%	CO1, CO2, CO3, CO4	C1, C2, C4
	Group Presentation	30%	CO1, CO2, CO3, CO4	C1, C2, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Jones, L. (1981). Functions of English. (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press.
2. Dixon, R.J. (1987). Complete course in English. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation)

REFERENCE BOOKS

1. Langan, J. (2005). College Writing Skills with Readings (6th Ed). McGraw-Hill Publication
2. Interactions 1 (Reading), John Langan, Latest edition, McGraw-Hill Publication
3. Headway Series – Advanced Level (2 parts with CDs): Oxford University Press Ltd.
4. Speak like Churchill stand like Lincoln - James C. Humes
5. Cambridge IELTS Practice Book
6. Selected Sample Reports and Selected Research Articles

REFERENCE SITE

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5.1.3.4 LANG 204 Bangla Language and Literature

COURSE INFORMATION

Course Code Course Title	: LANG 204 : Bangla Language and Literature	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

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CURRICULUM STRUCTURE

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SYNOPSIS/RATIONALE

বাংলা আমাদের মাতৃভাষা। বাংলা শুধু একটি ভাষাই নয়, বরং এর সাথে বাংলাভাষী মানুষদের সংস্কৃতি, ইতিহাস এবং স্বকীয়তা ওতপ্রোতভাবে জড়িত। এই ভাষা শেখার মাধ্যমে এ অঞ্চলের মানুষদের ঐতিহ্য, মূল্যবোধ এবং জীবনপ্রক্রিয়া সম্পর্কে সম্যক ধারণা লাভ করা যায়। সর্বোপরি 'বাংলা ভাষা ও সাহিত্য' বিষয়টি অধ্যয়নের মাধ্যমে স্নাতক (সম্মান) প্রোগ্রামের ছাত্রছাত্রীগণ এর তাত্ত্বিক

বিষয়ে যেমন দক্ষতা অর্জন করবে তেমনি এই কোর্স হতে লব্ধ ধারণা তাদের জ্ঞানের পরিধি ও সংস্কৃতি সম্পর্কে ধারণা বৃদ্ধি এবং এর প্রায়োগিক কৌশলসমূহ আরও ভালোভাবে রপ্ত করতে সাহায্য করবে

OBJECTIVE

১. বাংলা ভাষা, ব্যাকরণ ও সাহিত্যের মৌলিক বিষয়সম্পর্কেধারণা প্রদান ।
২. মাতৃভাষার শুদ্ধ উচ্চারণ শিক্ষা।
৩. পঠিত বিষয়ের ভাব অনুধাবন করা এবং তা প্রকাশে দক্ষ করে তোলা।
৪. বাংলা ভাষায় পেশাগত দাপ্তরিক পত্রালাপ (Official Correspondence) এবং সৃজনশীল রচনার জন্য প্রাতিষ্ঠানিক শিক্ষা প্রদান ।

<u>প্রয়োগিক উদ্দেশ্য</u>।

১. সৃজনশীল রচনায় বাংলা ভাষার দক্ষ প্রয়োগ।
২. মাতৃভাষায় শুদ্ধ উচ্চারণে বক্তব্য প্রদানে দক্ষতা অর্জন।
৩. লিখিত ও মৌখিক প্রয়োগে ভাষার সৌকর্য রক্ষা করা।
৪. মাতৃভাষায় দাপ্তরিক পত্রালাপে দক্ষতা অর্জন।

<u>পাঠ্যসূচী</u>।

১. সাহিত্য (প্রবন্ধ, গল্প ও কবিতা) - ৪০ নম্বর
২. ব্যাকরণ, ভাষা শিক্ষা ও বিরচন - ৬০ নম্বর

(প্রবন্ধ, গল্প ও কবিতাসমূহ ঢাকা বিশ্ববিদ্যালয় এবং ইউজিসি’র সিলেবাস হতে সংগৃহীত)

<u>নির্বাচিত প্রবন্ধ</u>			- ১৫ নম্বর
বাঙ্গালা ভাষা	-	বঙ্কিমচন্দ্র চট্টোপাধ্যায়	
তৈল	-	হরপ্রসাদ শাস্ত্রী	
<u>নির্বাচিত গল্প</u>			- ১৫ নম্বর
পুঁইমাচা	-	বিভূতিভূষণ বন্দোপাধ্যায়	
নয়নচারা	-	সৈয়দ ওয়ালীউল্লাহ	
<u>নির্বাচিত কবিতা</u>			- ১০ নম্বর
বিদ্রোহী	-	কাজী নজরুল ইসলাম	
বঙ্গভাষা	-	মাইকেল মধুসূদন দত্ত	

<u>ব্যাকরণ ও ভাষা শিক্ষা</u> - ২৫ নম্বর

(১) প্রমিত বাংলা বানানের নিয়ম।
(২) অশুদ্ধি সংশোধন।
(৩) বাগ্‌ধারা।
(৪) প্রবাদ প্রবচন।
(৫) এক কথায় প্রকাশ।
(৬) প্রশাসনিক পরিভাষা।
(৭) প্রায় সমোচ্চারিত ভিন্নার্থক শব্দ ।
(৮) বিভিন্ন শব্দের বিশিষ্টার্থে প্রয়োগ ।

<u>উচ্চারণবিধি</u> - ০৫ নম্বর

<u>বিরচন</u> - ৩০ নম্বর

(১) ইংরেজি থেকে বাংলা অনুবাদ/অনুচ্ছেদ রচনা।
(২) ভাব সম্প্রসারণ/সারাংশ/সারমর্ম।
(৩) পত্র/প্রতিবেদন রচনা ।
(৪) প্রবন্ধ রচনা ।

<u>বিস্তারিত পাঠ্যসূচি</u> । **মোট ক্রেডিট - ৩ (৪২পিরিয়ড):**

ক্র/নং	কোড নং	পাঠ্য বিষয়	পিরিয়ড সংখ্যা	মন্তব্য
সাহিত্য (২০ পিরিয়ড)				
১।	বাংলা:১-৪	প্রবন্ধ: বাঙ্গালা ভাষা	৪	
২।	বাংলা:৫-৭	প্রবন্ধ: তৈল	৩	
৩।	বাংলা:৮-১১	গল্প: পুঁইমাচা	৪	
৪।	বাংলা:১২-১৪	গল্প: নয়নচারা	৩	
৫।	বাংলা:১৫-১৮	কবিতা: বিদ্রোহী	৩	
৬।	বাংলা:১৯-২১	কবিতা: বঙ্গভাষা	৩	
ব্যাকরণ, ভাষা শিক্ষা ও মৌখিক প্রকাশ ক্ষমতার উন্নয়ন (১১ পিরিয়ড)				
৭।	বাংলা:২২-২৪	প্রমিত বাংলা বানানের নিয়ম	২	
৮।	বাংলা:২৫-২৬	অশুদ্ধি সংশোধন	২	
৯।	বাংলা:২৭	বাগ্ধারা	১	
১০।	বাংলা:২৮	প্রবাদ প্রবচন	১	
১১।	বাংলা: ২৯	এক কথায় প্রকাশ	১	
১২।	বাংলা: ৩০	প্রশাসনিক পরিভাষা	১	
১৩।	বাংলা: ৩১	প্রায় সমুচ্চারিত ভিন্নার্থক শব্দ	১	
১৪।	বাংলা: ৩২	বিভিন্ন শব্দের বিশিষ্টার্থে প্রয়োগ	১	
১৫।	বাংলা:৩৩-৩৪	উচ্চারণ বিধি	১	
বিরচন (০৫ পিরিয়ড)				
১৬।	বাংলা: ৩৫-৩৬	ইংরেজি থেকে বাংলা অনুবাদ/অনুচ্ছেদ রচনা	২	
১৭।	বাংলা: ৩৭	ভাবসম্প্রসারণ/সারাংশ/সারমর্ম	১	
১৮।	বাংলা: ৩৮	পত্র/প্রতিবেদন রচনা	১	

১৯।	বাংলা: ৩৯	প্রবন্ধ রচনা	১	
পরীক্ষা (০৬ পিরিয়ড)				
২০।	বাংলা: ৪০-৪২	**পরীক্ষা (২+৪)**	৬	
		মোট পিরিয়ড =	**৪২**	

পাঠদান কৌশল। প্রশিক্ষণের ক্ষেত্রে নিম্নলিখিত পদ্ধতি/উপায়সমূহ অনুসরণ করা হবে:

ক। বক্তৃতা।
খ। দলগত আলোচনা।
গ। মাল্টিমিডিয়া প্রেজেন্টেশান।
ঘ। নোট/সহায়কসামগ্রী প্রদান।
ঙ। ল্যাংগুয়েজ ল্যাবে প্রশিক্ষণ।
চ। স্পট/ক্লাস টেস্ট ইত্যাদি।

মূল্যায়নপদ্ধতি। মূল্যায়ন পদ্ধতি নিম্নরূপ:

ক্র. নং	বিষয়	নম্বর	মন্তব্য
১।	১×মিড টার্ম পরীক্ষা	২০%	১ ঘণ্টা, ২০ নম্বর
২।	ক্লাস টেস্ট	১০%	৩টি (২টির নম্বর জমা দেয়া হবে, ৫%+৫%)
৩।	অ্যাসাইনমেন্ট/ দলগত উপস্থাপনা/ ক্লাস পারফরমেন্স	১০%	
৪।	উপস্থিতি	১০%	
৫।	সেমিস্টার ফাইনাল পরীক্ষা	৫০%	৩ ঘণ্টা, ১০০ নম্বর
	সর্বমোট	১০০%	

REFERENCE BOOKS

সহায়ক গ্রন্থাবলি নিম্নরূপ:

১. বাংলা ব্যাকরণ - ড. শাহজাহান মুনীর, স্টুডেন্টস পাবলিকেশনস।
২. প্রবন্ধসংগ্রহ - ঢাকা বিশ্ববিদ্যালয়।
৩. গল্পসংগ্রহ - ঢাকা বিশ্ববিদ্যালয়।
৪. কবিতাসংগ্রহ - ঢাকা বিশ্ববিদ্যালয়।
৫. বাংলা বানান অভিধান - বাংলা একাডেমি কর্তৃক প্রকাশিত।
৬. বাংলা উচ্চারণ অভিধান - বাংলা একাডেমি কর্তৃক প্রকাশিত।
৭. প্রমিত বাংলা ব্যাকরণ ও নির্মিতি (তৃতীয় খণ্ড) - অধ্যাপক ড. হায়াৎ মামুদ ও অধ্যাপক ড. মোহাম্মদ আমীন।
৮. বাংলা ভাষার প্রয়োগ ও অপপ্রয়োগ - বাংলা একাডেমি কর্তৃক প্রকাশিত।

REFERENCE SITE

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5.1.4 Level-2, Fall

5.1.4.1 MATH 231 Complex Variables and Linear Algebra

COURSE INFORMATION			
Course Code	: MATH IV	Lecture Contact Hours	: 3.00
Course Title	: Complex Variable and Linear Algebra	Credit Hours	: 3.00

PRE-REQUISITE

Course Code: MATH 101, MATH 105

Course Title: Differential Calculus and Integral Calculus, Vector Analysis, Matrix and Co-ordinate Geometry

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To teach the students the concepts, principles and working field of Complex Variable and Linear Algebra. It is targeted to provide a basic foundation and applications of complex analysis and to develop the topics of analytic functions, the elementary functions and contour integration. Finally this course is designed to demonstrate practical applications and problems by using the sectors surrounding Complex Variable and Linear algebra.

OBJECTIVE

1. Be able to impart basic knowledge about Complex Variable and Linear algebra.
2. Be able to familiarize the students with the characteristics of Complex Integration.
3. Be proficient with basic methods of complex differentiation, different matrix decomposition and their application.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Recall** the basic idea about Complex Variable and Linear algebra.	C1-C2	1		1	T, F
CO2	**Explain** the complex functions by line integrals, Cauchy's integral formulae and Cauchy's residue theorem.	C2	1		2	T, Mid Term Exam, F
CO3	**Apply** various types of matrix decomposition to **solve** different engineering problems.	C3	1,3		2	T, Mid Term Exam, F

(C1 – Remember, C2 – Understand, C3 – Apply, C4 – Analyze, C5 – Evaluate, and C6 – Create; CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam, MT- Mid Term Exam)

COURSE CONTENT

Complex Variable: Complex number system, General functions of a complex variable, Limits and continuity of a function of complex variable and related theorems, Differentiation and the cauchy Riemann equations, Mapping by elementary functions, Line integral of a complex function, Cauchy's Integral formula, Complex function, Convergence and Uniform convergence, Liouville's theorem, Taylor's and Laurents theorem, Singular residues, Cauchy's residue theorem.

Linear Algebra:

Vector space and its basis and dimension. Linear Transformations; Kernel and range of linear transformations, Matrix Decomposition, LU Decomposition, QR decomposition, Eigen value decomposition, Singular Value Decomposition. Introduction to Principal Component Analysis (PCA), Independent Component Analysis (ICA), and Common Spatial Pattern (CSP).

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Recall** the basic idea about Complex Variable and Linear algebra.	3											
CO2	**Explain** the complex functions by line integrals, Cauchy's integral formulae and Cauchy's residue theorem.	3											
CO3	**Apply** various types of matrix decomposition to **solve** different engineering problems.	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics regarding Complex Variable, Linear algebra has to be applied to describe the operation of different components of Biomedical Engineering.
CO2-PO1(a)	**3**	In order to explain the characteristics of various components of Biomedical Engineering, the knowledge of mathematics regarding Complex Variable is needed.
CO3-PO1(a)	**3**	Matrix decomposition is required to interpret mathematics, science and engineering study.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY		
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method		
COURSE SCHEDULE		
Week 1	**COMPLEX VARIABLE**	**CT-1**
Class-1	Complex number system	
Class-2	Complex number system	
Class-3	General functions of a complex variable	
Week 2	**COMPLEX VARIABLE**	
Class-4	Limits and continuity of a function of complex variable and related theorems	
Class-5	Limits and continuity of a function of complex variable and related theorems	
Class-6	Limits and continuity of a function of complex variable and related theorems	
Week 3	**COMPLEX VARIABLE**	
Class-7	Differentiation of complex function	
Class-8	Differentiation of complex function	
Class-9	The Cauchy Riemann equations - concepts	
Week 4	**COMPLEX VARIABLE**	**CT-2**
Class-10	The Cauchy Riemann equations - problems	
Class-11	Mapping by elementary functions	
Class-12	Line integral of a complex function	
Week 5	**COMPLEX VARIABLE**	
Class-13	Cauchy's Integral formula,	
Class-14	Complex function,	
Class-15	Convergence	
Week 6	**COMPLEX VARIABLE**	
Class-16	Uniform convergence	
Class-17	Liouville's theorem	
Class-18	Taylor's theorem	
Week 7	**COMPLEX VARIABLE**	
Class-19	Laurents theorem	
Class-20	Singular residues	
Class-21	Cauchy's residue theorem	
Week 8	**LINEAR ALGEBRA**	

Class-22	Vector space and its basis.	**Mid Term**
Class-23	Vector space and its dimension.	
Class-24	Linear Transformations	
Week 9	**LINEAR ALGEBRA**	
Class-25	Kernel of linear transformations	
Class-26	Kernel of linear transformations	
Class-27	Range of linear transformations	
Week 10	**LINEAR ALGEBRA**	
Class-28	Range of linear transformations	
Class-29	Matrix Decomposition	
Class-30	LU Decomposition	
Week 11	**LINEAR ALGEBRA**	**CT-4**
Class-31	DU Decomposition	
Class-32	QR decomposition	
Class-33	QR decomposition	
Week 12	**LINEAR ALGEBRA**	
Class-34	Eigen value decomposition	
Class-35	Singular Value Decomposition.	
Class-36	Singular Value Decomposition.	
Week 13	**LINEAR ALGEBRA**	
Class-37	Introduction to Principal Component Analysis (PCA)	
Class-38	Introduction to Principal Component Analysis (PCA)	
Class-39	Independent Component Analysis (ICA)	
Week 14	**LINEAR ALGEBRA**	
Class-40	Independent Component Analysis (ICA)	
Class-41	Common Spatial Pattern (CSP).	
Class-42	Common Spatial Pattern (CSP).	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO3	C3
	Class Participation	5%	CO3	C3
	Mid term	15%	CO2, CO3	C2,C3
Final Exam		60%	CO 1	C1, C2
			CO 2	C2
			CO 3	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. **Theory and functions of complex variables, Shanti Narayan.**

REFERENCE BOOKS

1. **Complex Variables by -Murray R. Spiegel, Schaum's Outline Series.**
2. **Elementary Linear algebra - Wiely, Howard Anton and Chris Rorres.**

REFERENCE SITE

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5.1.5 Level-3, Spring

5.1.5.1 GERM 352 Fundamentals of Research Methodology (Sessional)

COURSE INFORMATION			
Course Code Course Title	: GERM 352 : Fundamentals of Research Methodology (Sessional)	Lecture Contact Hours Credit Hours	: 4.00 : 2.00
PRE-REQUISITE			
None			

CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
The *Fundamentals of Research Methodology* is a hands-on course designed to impart education in the foundational methods and techniques of academic research in Science and Engineering context. UG students would examine and be practically exposed to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, time management, report writing, and presentation. Once equipped with this knowledge, participants would be well-placed to conduct disciplined research under supervision in an area of their choosing. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.
OBJECTIVES
1. To develop a research orientation among the UG students and to acquaint them with fundamentals of research methods. 2. To evaluate/review related extant literature, form a variety of sources, pertinent to the research objectives/questions. 3. To expose students to various research methodologies (design), relevant to the research problem needing to be addressed. **4.** To explain and justify how researchers will collect and analyse research data. **5.** To educate students in the common mistakes, research misconduct, and ethical considerations in the field of research methodology.
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Corresponding PO	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the research fundamentals and **formulate** problem statement and research questions/objectives.	2	C2	-			Assignment/ Quiz
CO2	Be able to **formulate** and **compose** a research proposal considering research activities/design, background studies, and following standard guidelines.	4	C3	-			Report/Presentation/ Assignment/ Quiz
CO3	Be able to **develop** writing and presentation skill, and **demonstrate** ethical considerations in conducting research.	10	C3	-			Report/Presentation/ Assignment

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam, MT- Mid Term Exam;
C1 – Remember, C2 – Understand, C3 – Apply, C4 – Analyze, C5 – Evaluate, and C6 – Create

COURSE CONTENT

1. Foundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theory, empiricism, deductive and inductive theory; Characteristics of scientific method.
2. Problem Identification and Formulation: Meaning and need of Review of Literature; How to Conduct the Review of literature; Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.
3. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental/Computational Design: Concept of Independent & Dependent variables.
4. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
5. Research Misconduct and Ethics: Understand the research misconduct; type of research misconduct; Ethical issues in conducting research; Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
6. Use of Tools / Techniques for Research: Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts.

CO-PO MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the research fundamentals and **formulate** problem statement and research questions/objectives.		3										
CO2	**Formulate** and **compose** a Research proposal considering research activities, background studies, and following standard guidelines.				3								
CO3	**Develop** writing and presentation skill, and **demonstrate** ethical considerations in conducting research.										3		

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	24
Practical / Tutorial / Studio	12
Student-Centred Learning	12
Self-Directed Learning	
Non-face-to-face learning	12
Report Preparation	18
Formal Assessment	
Continuous Assessment	1.5
Report Submission (2)	-
Presentation (2)	0.5
Total	80

TEACHING METHODOLOGY

Lecture and Discussion, Mini-Seminars by Experts, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Lecture	Topics
1	Lec 1 Lec 2 Lec 3 Lec 4	Foundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theory, empiricism, deductive and inductive theory; Characteristics of scientific method.
2	Lec 5 Lec 6 Lec 7 Lec 8	Practice session on Foundations of Research
3	Lec 9 Lec 10 Lec 11 Lec 12	Problem Identification & Formulation: Meaning & need of Review of Literature; How to Conduct the Review of literature; Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.
4	Lec 13 Lec 14 Lec 15 Lec 16	Practice session on Problem Identification & Formulation
5	Lec 17 Lec 18 Lec 19 Lec 20	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.
6	Lec 21 Lec 22 Lec 23 Lec 24	Practice session on Research Design
7	Lec 25 Lec 26 Lec 27 Lec 28	Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
8	Lec 29 Lec 30 Lec 31 Lec 32	Practice session on Data Analysis
9	Lec 33 Lec 34 Lec 35 Lec 36	Research Misconduct and Ethics: Understand the research misconduct; type of research misconduct; Ethical issues in conducting research; Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
10	Lec 37 Lec 38 Lec 39 Lec 40	Practice session on Research misconduct and Ethics
11	Lec 41 Lec 42 Lec 43 Lec 44	Use of Tools / Techniques for Research: Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts.
12	Lec 45 Lec 46 Lec 47	Practice session on Use of tools / techniques for Research

	Lec 48	
13	Lec 49 Lec 50 Lec 51 Lec 52	Review Session (Theory) – I /Final Presentation
14	Lec 53 Lec 54 Lec 55 Lec 56	Review Session (Practice) – II /Final Presentation

ASSESSMENT STRATEGY

Assessment Criteria		CO	Blooms Taxonomy
Components	Grading		
Assignment I	20%	CO1 and CO3	C2, C3
Assignment II	50%	CO2 and CO3	C3
Continuous Assessment	30%	CO1 and CO2	C2, C3
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Engineering Research Methodology: A Practical Insight for Researchers. Springer, by Deb, Dipankar, Dey, Rajeeb, Balas, Valentina E.
2. Research Methods for Engineers, 1st Edition, by David V. Thiel.

REFERENCE BOOKS

1. Handbook of Research Methodology by Talati, J.K.
2. Introducing Research Methodology: A Beginner's Guide to Doing a Research Project by Uwe Flick
3. DRM, a Design Research Methodology by Lucienne T.M. Blessing and Amaresh Chakrabarti
4. Research Methods: Information, Systems, and Contexts by Kirsty Williamson, Graeme Johanson
5. Zelkowitz, M. V. and Wallace, D. R. (1998), Experimental models for validating technology, *Computer*, vol. 31, no. 5, pp. 23-31.
6. Internet, mail, and mixed-mode surveys : the tailored design method (3rd ed.) by Dillman, D. A., Smyth, J. D., & Christian, L. M.
7. Applied multiple regression/correlation analysis for the behavioral sciences (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates, by Cohen, J., Cohen, P., West, S., & Aiken, L.
8. Experimental and Quasi-Experimental Design for Generalized Causal Inference. Boston, Mass: Houghton Mifflin, by Shadish W.R., Cook T.D. & Campbell P.T.

REFERENCE SITES

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5.1.6 Level-4, Spring

5.1.6.1 GEPM 481 Project Management and Finance

COURSE INFORMATION

Course Code Course Title	: GEPM 481 : Project Management and Finance	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course provides the students with the ability to predict as many dangers and problems as possible and to plan, organize and control activities so that one project can be completed as successfully as possible in spite of all the risks. Illustrates the principles to protect the environment by ensuring that a local planning authority when deciding whether to grant planning permission for a project which likely to have significant effects on environment.

OBJECTIVE

1. Successful development of projects procedures of initiation, planning, execution, regulation and closure as we the guidance of the project team's operation towards achieving all the agreed upon goals within the set scope, time, quality and budget standards.
2. Develop, implement, monitor and maintain environmental strategies, policies, programs and systems that pro sustainable development.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **list** and **describe** the selection and initiation of individual projects and of portfolios of projects in the enterprise.	C1, C2	1,11	1	-	1	T, F
CO2	Be able to **prepare** project planning activities that accurately forecast project costs, timelines and quality. **Implement** processes for successful resource, communication and risk and change management.	C3	1,3,12	1,2	-	1,3	T, F
CO3	Be able to **demonstrate** effective project execution & control techniques and **conduct** project closure activities to obtain formal project acceptance.	C2-C4	1,8	1	-	1	MID, F
CO4	Be able to **demonstrate** effective organizational leadership and change skills for financial management, managing projects, projects teams and stakeholders.	C2	4,10,11		-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Project Management: Definition of Project Management, Project Management Life Cycle, Economic Contexts of Project Management, Project Management in Healthcare Environment, Decision Making Tools for Choosing a Project, Estimating Time, Scheduling Tool, Estimating Cost, Cost Categories, Assessing Cost, Cost Estimation Tools, Project Quality Management, Project Quality Control, Project Quality Assurance, The Process of Communicating, Communication Management Plan, Dealing with Changes, Monitoring and Control Changes, Risk Definition, Identification, Responding and Monitoring, Contract Definition, Types and Organizing Contracts, Procurement Process: Pre-Purchase, Purchase, Post- Purchase, Contract Administration and Close Out, Project Close Out, Roles of Project Manager, Motivation, Teaming and Leadership, Negotiating and Conflict Management, Project Management in Pharmaceutical Industry, Project Management in Medical Device Manufacturing Industry, Sustainability and Green Efforts in Healthcare

Finance: Corporate Finance and Finance Manager, Forms of Business Organization, Goal of Financial Management, Cash Flow, Ratio Analysis, Financial Planning and Financial Planning Model, Percentage of Sales Approach, External Financing and Growth

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **list** and **describe** the selection and initiation of individual projects and of portfolios of projects in the enterprise.	3										3	
CO2	Be able to **prepare** project planning activities that accurately forecast project costs, timelines and quality. **Implement** processes for successful resource, communication and risk and change management.	3		3									3
CO3	Be able to **demonstrate** effective project execution & control techniques and **conduct** project closure activities to obtain formal project acceptance.	3							2				
CO4	Be able to **demonstrate** effective organizational leadership and change skills for financial management, managing projects, projects teams and stakeholders.				2						2	3	

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Motivation and course introduction**	
Lecture 1	Introduction to Project Management and Economic Context of Project Management	
Lecture 2	Decision Making Tools for choosing a Project	
2	**Introductory Concepts of Project Management**	**CT – 1, Final**

Lecture 3	Strategy, Strategy Implementation and Project Management	
Lecture 4	Organizing Structure Influence on Project Choices and Project Selection	
3	**Time Management**	
Lecture 5	Introductory Concepts of Time Management	
Lecture 6	Estimation and Scheduling Tool	
4	**Cost Management**	**Midterm, Final**
Lecture 7	Introductory Concepts of Cost Management, Estimating Cost and Cost Estimating Tools	
Lecture 8	Assessing Costs and Allocating Budget Costs	
5	**Quality Management**	
Lecture 9	Introductory Concepts of Quality Management	
Lecture 10	Project Quality Control, Quality Assurance and Quality Assessment	
6	**Communication, Adaptability and Risk Management**	
Lecture 11	Communication: The Process of Communication and Communication Management Plan	
Lecture 12	Adaptability and Risk Management	
7	**Contracting-Procurement and Project Close out**	
Lecture 13	Contract Definition, Types and Organizing Contracts	
Lecture 14	Procurement Process, Project Close Out	
Midterm Break		
8	**Management Skills**	**CT – 2, Final**
Lecture 15	Role of Project Manager: Motivation, Teaming and Leadership	
Lecture 16	Negotiating and Conflict Management	
9	**Project Management in Healthcare - 1**	
Lecture 17	Project Management in Pharmaceutical Industry	
Lecture 18	Project Management in Medical Device Manufacturing Industry	
10	**Project Management in Healthcare - 2**	
Lecture 19	Sustainability in Healthcare	
Lecture 20	Healthcare Agility	
11	**Introduction to Corporate Finance**	**CT – 3, FINAL**
Lecture 21	Corporate Finance and Finance Manager	
Lecture 22	Forms of Business Organization, Goal of Financial Management	
12	**Financial Statements, Taxes and Cash Flow**	
Lecture 23	Balance Sheet	
Lecture 24	Income Statement, Taxes	
13	**Cash Flow and Ratio Analysis**	**FINAL**
Lecture 25	Cash Flow	
Lecture 26	Ratio Analysis	
14	**Financial Planning and Corporate Growth**	
Lecture 27	Financial Planning and Financial Planning Model	
Lecture 28	Percentage of Sales Approach, External Financing and Growth	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1,C2,C3
	Class Participation	5%	CO1	C1,C2
	Midterm	15%	CO1,CO2	C1,C2,C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
			CO 4	CO 4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. David Shirley, Project Management for Healthcare, Second Edition, Taylor & Francis.

REFERENCE BOOKS

1. Larson,E.W. andGray,C.F.(2018),Project management the managerial process, Seventh Edition,McGraw-Hill
2. Fundamentals of Corporate Finance 8th Canadian Edition

REFERENCE SITE

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5.1.7 Level-4, Fall

5.1.7.1 GESL 421 Environment, Sustainability and Law

COURSE INFORMATION			
Course Code Course Title	: GESL 421 : Environment, Sustainability, and Law	Lecture Contact Hours Credit Hours	: 2.00 : 2.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course introduces students to the considerations that need to be made for the environment and sustainability. National and international laws governing the protection of the environment, the relation between sustainable development and environmental protection, the roles involved in adhering to environmental laws, and the ethical obligations towards the environment are covered. Biosafety principles and practices for facilities, safe disposal of biohazardous and medical waste management, biosafety from a hospital perspective are also covered.

OBJECTIVE

1. To be familiar with the basic concepts of environmental protection and sustainability required to be followed internationally.
2. To have knowledge of the areas where rules and ethics for environmental protection are applied.
3. To correctly identify biosafety concerns and apply the principles for biosafety protection and contamination control depending on the scenario.
4. To be aware of the considerations for the environment and responsibilities of individuals, health organizations and industries in the safe treatment and disposal of hazardous wastes in hospitals.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **remember** environmental laws and sustainability concepts and the issues they are designed to resolve.	C1	7	-	-	7	T, MID, F
CO2	Be able to **understand** the applicable areas and methods for maintaining biosafety principles and hospital waste management.	C2	7	-	-	7	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

Introduction to Environmental Law and Sustainability: Principles of International environmental law; Sustainable development; Environmental Politics and Economics; Environmental Ethics; International organizations and common laws; Developed and Developing Countries Perspectives; Environmental Law in Bangladesh; Principles of Preventive Action and Precaution; International Environmental Problems; The role of regulation and innovation; Liability in Trade and Business; The Atmosphere and the Climate; Climate Change and Greenhouse effect; Ozone Layer Protection; Renewable Energy; Green Technology; The Link between Environment and Development; Preservation of Biodiversity and the Ecosystem; Marine Pollution and Biodiversity; Laws against Pollution.

Biosafety: Identifying Biological Safety Concerns; Biohazard Risk Assessment; Routes of Contamination; Methods for Hazard Control; Administrative Responsibilities in Contamination Control; Facility Design Considerations. Hospital Waste Management: Introduction to biomedical waste management in hospital; Responsibility of Staff and Visitors in Contamination Control; Treatment and Disposal Techniques; Water and Air Purification; Biosafety Consideration for Patients: Equipment Sterilization: Disinfection Techniques; Recycled Materials: Bedsheets, gowns, surgical equipment, etc.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **remember** environmental laws and sustainability concepts and the issues they are designed to resolve							3					
CO2	Be able to **understand** the applicable areas and methods for maintaining biosafety principles and hospital waste management.							3					

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision of the previous and (or) subsequent lecture at home	14
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Weeks	Topics	Assessment
Weeks 1	**Introduction to environment, sustainability and law**	**CT – 1 and Midterm, Final**
Lecture 1	Principles of international environmental laws	
Lecture 2	Sustainable development and the environment	
Weeks 2	**Environment laws**	
Lecture 3	Environmental Politics and Economics	
Lecture 4	Environmental Ethics	

Weeks 3	**Environment laws**	
Lecture 5	International organizations and common laws	
Lecture 6	Developed and Developing Countries Perspectives; Environmental Law in Bangladesh	
Weeks 4	**Environment laws**	
Lecture 7	Principles of Preventive Action and Precaution	
Lecture 8	International Environmental Problems	
Weeks 5	**Sustainable Development**	**Midterm, Final**
Lecture 9	The role of regulation and innovation	
Lecture 10	Liability in Trade and Business	
Weeks 6	**The Atmosphere**	
Lecture 11	The Atmosphere and the Climate; Climate Change	
Lecture 12	Greenhouse effect; Ozone Layer Protection	
Weeks 7	**Development**	
Lecture 13	Renewable Energy; Green Technology	
Lecture 14	The Link between Environment and Development	
MIDTERM		
Weeks 8	**Biodiversity**	**CT – 2, FINAL**
Lecture 15	Preservation of Biodiversity and the Ecosystem	
Lecture 16	Marine Pollution and Biodiversity; Laws against Pollution	
Weeks 9	**Biosafety**	
Lecture 17	Identifying Biological Safety Concerns	
Lecture 18	Biohazard Risk Assessment	
Weeks 10	**Contamination Control**	
Lecture 19	Routes of Contamination & Methods for Hazard Control	
Lecture 20	Administrative Responsibilities & Facility Design Considerations	
Weeks 11	**Hospital Biosafety**	**CT – 3, FINAL**
Lecture 21	Introduction to biomedical waste management in hospital	
Lecture 22	Responsibility of Staff and Visitors in Contamination Control	
Weeks 12	**Maintaining Disease-free Environment**	
Lecture 23	Treatment and Disposal Techniques	
Lecture 24	Water and Air Purification	
Weeks 13	**Biosafety Consideration for Patients**	
Lecture 25	Equipment Sterilization: Disinfection Techniques	
Lecture 26	Recycled Materials: Bedsheets, gowns, surgical equipment, etc.	
Weeks 14	**Review Class**	-
Lecture 27	Review 1	
Lecture 28	Review 2	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
	Class Participation	5%	CO2	C2
	Midterm	15%	CO1, CO2	C1, C2
Final Exam		60%	CO 1	C1
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Thomas Schoenbaum and Michael J. Young, International Environmental Law: Cases, Materials, Problems, Second Edition.

REFERENCE BOOKS

1. Wooley, Dawn P., Byers, Karen B., Biological Safety Principles and Practices, Fifth Edition.

REFERENCE SITE

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5.1.7.2 GEEM 451 Engineering Ethics and Moral Philosophy

COURSE INFORMATION			
Course Code Course Title	: GEEM 351 : Engineering Ethics and Moral Philosophy	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
PRE-REQUISITE			
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CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
This course prepares students for the responsibilities and accountability in their industrial career as a biomedical engineer. Ethical principles and guidelines to be followed in major areas for biomedical engineers such as engineering, manufacturing, medicine, genetics, and research are taught. Codes of conduct as established by institutions, professional conduct, responsibilities of engineers, rights of individuals and subjects involved in biomedical research are also explored in sufficient details.			
OBJECTIVE			
1. To understand the core principles, applicable areas, and necessities of engineering ethics and moral obligations. **2.** To recognize the responsibilities and expectations of an engineer in applying ethics to protect individual, intellectual, and institutional rights according to the accepted code of ethics for engineers by institutions. **3.** To apply guidelines of bioethics in hospital, device development, and biomedical research requiring involvement of patients and live subjects without causing harm or violating moral rules.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** principles of ethics, moral obligations, and rights	C2	8	-	-	7	T, MID, F
CO2	Be able to **understand** the ethical codes to abide by in the industry and **apply** them following established guidelines	C2, C3	8, 11	5	-	7	T, MID, F
CO3	Be able to **understand** the bioethics in major areas of research and application such as hospitals, genetic research, and **apply** them in a safe manner	C2, C3	8, 11	5	-	7	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 – Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

ETHICS AND MORAL PHILOSOPHY:

Introduction to Engineering Ethics and Moral Philosophy; Ethics, Values, and Reason

Interests and Consequences; Conflicts of Interests; Moral Obligations and Rights.

Moral Obligations and Moral Rules in Engineering

Negative and Positive, and Universal and Special, Obligations and Rules, Moral rights.

Rights of Privacy/Confidentiality and Intellectual Property

Rights of Privacy and Confidentiality, Intellectual Property Rights.

Institutionalization of Ethical Conduct

The Ethics of Engineering Organizations, Institutional Review Board Determination, Biomedical Engineering Society Code of Ethics.

Major Bioethical areas

Bioethics in Genetically modified organisms and Cloning, Bioethics in Neuronal engineering, Bioethics in Human research and Animal testing, Bioethics in Hospital service, Bioethics in Medical device development, Bioethics in Rehabilitation engineering, Bioethics in Organ transplantation and regenerative medicine, Public Health and Bioterrorism.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to understand principles of ethics, moral obligations, and rights								3				
CO2	Be able to understand the ethical codes to abide by in the industry and apply them following established guidelines								3			2	
CO3	Be able to understand the bioethics in major areas of research and application such as hospitals, genetic research, and apply them in a safe manner								3			2	

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY		
Lecture and discussion, Co-operative and collaborative method, Problem based method		
COURSE SCHEDULE		
Weeks	**Topics**	**Assessment**
Weeks 1	**Introduction to Ethics and Moral Philosophy**	**CT – 1 and Midterm, Final**
Lecture 1	Ethics, Values, and Reason	
Lecture 2	Ethics in Popular Culture and in Reality	
Weeks 2	**Interests and Consequences**	
Lecture 3	Interests and Conflicts of Interest	
Lecture 4	Consequences: Harms, Benefits, and Risks	
Weeks 3	**Moral Obligations and Moral Rules in Engineering**	
Lecture 5	Negative and Positive, and Universal and Special, Obligations and Rules	
Lecture 6	Moral rights	
Weeks 4	**Rights of Privacy/Confidentiality and Intellectual Property**	
Lecture 7	Rights of Privacy and Confidentiality	
Lecture 8	Intellectual Property Rights	
Weeks 5	**Institutionalization of Ethical Conduct**	**Midterm, Final**
Lecture 9	The Ethics of Engineering Organizations	
Lecture 10	Institutional Review Board Determination	
Weeks 6	**The Bioethical Engineer**	
Lecture 11	Practice in Engineering; Code of Ethics for Engineers	
Lecture 12	Biomedical Engineering Society Code of Ethics	
Weeks 7	**Bioethics in Genetically modified organisms and Cloning**	
Lecture 13	Genetic modification of human and animal	
Lecture 14	Ethical issues in Cloning	
MIDTERM		
Weeks 8	**Bioethics in Neuronal engineering**	**CT – 2, FINAL**
Lecture 15	Neuroethics	
Lecture 16	Ethical issues in Artificial intelligence	
Weeks 9	**Bioethics in Human research and Animal testing**	
Lecture 17	Clinical trials	
Lecture 18	Ethics of using animal models	
Weeks 10	**Bioethics in Hospital service**	
Lecture 19	General Medical ethics, The Patient-Physician Relationship, Autonomy and Privacy of Patients; (case study)	
Lecture 20	Ethics and data mining, Ethical consideration in Clinical engineering	
Weeks 11	**Bioethics in Medical device development**	**CT – 3, FINAL**
Lecture 21	Ethical Issues in Design and Manufacturing	
Lecture 22	FDA regulations for medical devices	
Weeks 12	**Bioethics in Rehabilitation engineering**	

Lecture 23	Ethical concern in rehabilitation engineering	
Lecture 24	Ethics of Biomaterials for implants	
Weeks 13	**Bioethics in Organ transplantation and regenerative medicine**	
Lecture 25	Ethical issues in organ donation and social taboo	
Lecture 26	Ethics in stem cell research and therapy	
Weeks 14	**Bioethics in Biological Warfare**	
Lecture 27	Understanding the biological warfare	**FINAL**
Lecture 28	Bioethics in biological warfare	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C3
	Class Participation	5%	CO3	C2, C3
	Midterm	15%	CO2	C2, C3
Final Exam		60%	CO 1	C2
			CO 2	C2, C3
			CO 3	C2, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.

REFERENCE BOOKS

1. Biomedical Ethics for Engineers: Ethics and Decision Making in Biomedical and Biosystem Engineering by Daniel A. Vallero, Academic Press, 2007.

REFERENCE SITE

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5.2 Department of Electrical, Electronic and Communication Engineering

5.2.1 Level-1, Spring

5.2.1.1 EECE 191 Principles of Electrical Engineering

COURSE INFORMATION			
Course Code Course Title	: EECE 191 : Principles of Electrical Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome-Based Education (OBE)

SYNOPSIS/RATIONALE

To learn the basics of electrical circuit components, analysis of DC and AC circuits and the basics of electrical machines. The course covers the following modules: DC and AC circuits, DC Generator, DC Motor, AC Machines, and Transformer.

OBJECTIVE

1. To understand the basics of AC and DC circuits.
2. To apply different laws of circuit theorems for solving various engineering problems.
3. To explain the behavior of different electrical machines.
4. To analyze different circuit-related complex engineering problems efficiently.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basics of AC and DC circuits	C2	1	1	-	1,3	T, F
CO2	Be able to **apply** different laws of circuit theorems for solving various engineering problems.	C3	2	1,3	-	1,3	T, F
CO3	Be able to **understand** the behavior of different electrical machines.	C2	1	1	-	1	MID, F
CO4	Be able to **analyze** different circuit-related complex engineering problems efficiently.	C4	2	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 – Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Fundamentals of electrical circuit: Ohm's Law, Kirchhoff's voltage and current laws, Delta-wye transformation, Basic concept on AC and DC circuits, RL, RC, RLC-based AC circuit, Impedance in series, parallel branches, series-parallel circuits, Resonance in AC circuits, Transient response of capacitor and inductor circuits. Electrical networks: Network analysis methods of branch and loop currents, Nodal circuit analysis, Thevenin's, and Norton's theorems. Effective current and voltage: Average values, Form factor, Crest factor, Concept of real and reactive power. Introduction to phasor algebra: Impedance in polar and Cartesian forms, Sinusoidal single-phase circuit analysis, Impedance measuring by vector diagram. Balanced polyphase circuits: Three-phase four-wire and three-

phase three-wire system of electrical load, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three-phase circuit analysis, and power measurement.
DC Generator: Working principle, types, performances, and characteristics. DC Motor: Working principle, types, performances, speed control, starters and characteristics, AC Machines: Three-phase induction motor principles, equivalent circuit, single-phase induction motor principle, Principles of AC generator. Transformer: Principles of singe and three-phase transformer, Equivalent circuit of single-phase transformer, Different losses of transformers, Instrument Transformer, Applications of various machines in the Biomedical Engineering Field. Technical specifications of different electrical machines.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basics of AC and DC circuits	3											
CO2	Be able to **apply** different laws of circuit theorems for solving various engineering problems.		3										
CO3	Be able to **understand** the behavior of different electrical machines.	3											
CO4	Be able to **analyze** different circuit-related complex engineering problems efficiently.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Fundamentals of Electrical Circuits**	**CT – 1, Final**
Lecture 1	Ohm's Law, Kirchhoff's voltage and current laws, Series-Parallel circuits	
Lecture 2	Voltage and current division, Delta-wye transformation	
Lecture 3	Basic concept on AC and DC circuits, RL, RC and RLC-based AC circuit	
2	**Fundamentals of Electrical Circuits (Cont...)**	

Lecture 4	Impedance in series and parallel branches,	
Lecture 5	Concept of resistance, reactance, inductance, capacitance, susceptance, admittance, and impedance	
Lecture 6	Finding impedance of series-parallel AC circuits	
3	**Fundamentals of Electrical Circuits (Cont...)**	
Lecture 7	Resonance in AC circuits	
Lecture 8	Transient response of capacitor and inductor circuits	
Lecture 9	Sinusoidal-steady-state response	
4	**Electrical Network Analysis**	**CT – 2, Final**
Lecture 10	Network analysis methods of branch and loop currents	
Lecture 11	Nodal circuit analysis, Mesh Circuit Analysis	
Lecture 12	Superposition Theorem	
5	**Electrical Network Analysis and Effective Current and Voltage**	
Lecture 13	Thevenin’s and Norton’s theorems	
Lecture 14	Features of AC signal, Average values, RMS value, Form factor, Crest factor, and relevant mathematical problem	
Lecture 15	Concept of real and reactive power and relevant mathematical problems	
6	**Introduction to Phasor Algebra**	
Lecture 16	Impedance in polar and Cartesian forms	
Lecture 17	Sinusoidal single-phase circuit analysis	
Lecture 18	Impedance measuring by vector diagram.	
7	**Balanced Poly Phase Circuits**	
Lecture 19	Three-phase four-wire and three-phase three-wire system of electrical load	
Lecture 20	Balanced wye loads, balanced delta loads	
Lecture 21	Power in balanced systems	
Midterm Break		
8	**Balanced Poly Phase Circuits (Continue)**	**Midterm, Final**
Lecture 22	Power factor measurement of single and 3 phase systems,	
Lecture 23	Balanced three-phase circuit analysis and Power measurement	
Lecture 24	Some related mathematical problem solving	
9	**DC Generator**	
Lecture 25	Working principles of DC generator	
Lecture 26	Basic components and types of DC generator	
Lecture 27	Performances and Characteristics, applications of DC generator	
10	**DC Motor**	
Lecture 28	Working principle of DC motor	
Lecture 29	Basic components and types of DC motor	
Lecture 30	Performances and characteristics, speed control of DC motor	
11	**DC Motor (Cont…) and AC Machines**	**CT – 3, Final**
Lecture 31	Different starters of DC motor	
Lecture 32	Applications of DC motor	
Lecture 33	Principles of three-phase induction motor and its equivalent circuit	
12	**AC Machines**	
Lecture 34	Principles of Single phase induction motor and its equivalent circuit	
Lecture 35	Principles of AC generator	
Lecture 36	Principles of Synchronous Motor and its application	
13	**Transformer**	**FINAL**
Lecture 37	Principles of singe and three-phase transformer	

Lecture 38	Equivalent circuit of single-phase transformer	
Lecture 39	Different loses and efficiencies of transformers and relevant mathematical problems	
14	**Transformer (Cont...)**	
Lecture 40	Instrument transformers	
Lecture 41	Applications of various machines in the Biomedical Engineering Field	
Lecture 42	Familiarization with Technical specifications of different electrical machines.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

Text Books

1. Fundamentals of Electric Circuits- Alexander & Sadiku.
2. Alternating Current Circuits – Russell & George F. Corcoran; John Wiley and Sons.

REFERENCE BOOKS

1. Introductory Circuit Analysis - R.L. Boylestad; Prentice Hall of India Private Ltd.
2. Electrical Machinery Fundamentals- Stephen J Chapman
3. A Textbook of Electrical Technology - B.L Theraja

REFERENCE SITE

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5.2.1.2 EECE 192 Principles of Electrical Engineering Sessional

COURSE INFORMATION

Course Code	: EECE 192	Lecture Contact Hours	: 3.00
Course Title	: Principles of Electrical Engineering Sessional	Credit Hours	: 1.50

PRE-REQUISITE

EECE 191: Principles of Electrical Engineering

CURRICULUM STRUCTURE

Outcome-Based Education (OBE)

SYNOPSIS/RATIONALE

To learn the basics of electrical circuit components, analysis of DC and AC circuits and the basics of electrical machines. DC and AC circuits, DC Generator, DC Motor, AC Machines, and Transformer module will be covered by this course.

OBJECTIVE

This course aims to practically implement the concepts of AC and DC circuits and learn the principle and applications of different electrical machines.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** different laws of circuit theorems for solving various engineering problems.	C3	2	1	-	1, 3	T, Q, R
CO2	Be able to **understand** the behavior of different electrical machines.	C2	1	1, 3	-	1, 2, 3	T, Q, R
CO3	Be able to **analyze** different circuit-related complex engineering problems efficiently.	C4	2	1	-	1, 3	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Construction and operation of simple electrical circuits (Ohm's Law, Series-Parallel, Voltage Divider etc.), KVL and KCL, Superposition Theorem, Thevenin's theorem, alternating current (ac) waves and R-L-C series circuit, the principles and properties of DC Generator, principles and properties of DC Motor, principles and properties of Alternator, principles, and properties of Transformer. Familiarization with the technical specifications of various Electrical Machines

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** different laws of circuit theorems for solving various engineering problems.		3										
CO2	Be able to **understand** the behavior of different electrical machines.	3											
CO3	Be able to **analyze** different circuit-related complex engineering problems efficiently.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for the final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Construction and operation of simple electrical circuits	Report, Lab Test, Quiz, Viva
2	Verification of KVL	
3	Verification of KCL	
4	Verification of Superposition Theorem	
5	Verification of Thevenin's theorem	
6	Lab Test 1	
7	Familiarization with alternating current (ac) waves	
	Midterm Break	
8	Study of R-L-C series circuit	Report, Lab Test, Quiz, Viva
9	Experiment on the principles and properties of DC Generator	
10	Experiment on the principles and properties of DC Motor	
11	Experiment on the principles and properties of Alternator	
12	Experiment on the principles and properties of Transformer	
13	Lab Test 2	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Fundamentals of Electric Circuits- Alexander & Sadiku.
2. Alternating Current Circuits – Russell & George F. Corcoran; John Wiley and Sons.

REFERENCE BOOKS

1. Introductory Circuit Analysis - R.L. Boylestad; Prentice Hall of India Private Ltd.
2. Electrical Machinery Fundamentals- Stephen J Chapman
3. A Textbook of Electrical Technology - B.L Theraja

REFERENCE SITE

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5.2.2 Level-2, Spring

5.2.2.1 EECE 291 Electronic Circuits and Devices

COURSE INFORMATION			
Course Code Course Title	: EECE 291 : Electronic Circuits and Devices	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

EECE 191: Principles of Electrical Engineering

CURRICULUM STRUCTURE

Outcome-Based Education (OBE)

SYNOPSIS/RATIONALE

To teach the students about the concepts, principles, and working of basic electronic circuits. It is targeted to provide a basic foundation for technology areas like electronic devices, communication systems, industrial electronics, instrumentation, control systems, and various electronic circuit designs.

OBJECTIVE

1. To understand the basics of electronic devices like Diode, Transistor, MOSFET, Op-Amp, etc., and its applications.
2. To become skilled at designing different electronic circuits like rectifiers, amplifiers, active filters, etc. using electronic devices.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** semiconductor devices' basic operation and characteristics like diodes, BJTs, and FETs.	C2	1	1	-	1,3	T, F
CO2	Be able to **apply** the established equivalent models to find the important ac parameters for an amplifier.	C3	1	1,3	-	1,3	T, F
CO3	Be able to **analyze** the DC and AC output response of a network designed with BJT and become acquainted with the BJT amplifiers' design process.	C4	2	1	-	1, 3	MID, F
CO4	Be able to **understand** the characteristics of Op-Amps and its applications.	C2	2	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Semiconductors; P-type and n-type semiconductors, p-n junction diode characteristics, Diode applications, half and full-wave rectifier, clipping and clamping circuits; regulated power supply using Zener diode. Bipolar junction transistor (BJT), principle of operation, I-V characteristics, Transistor circuits configurations (CB, CE and CC), BJT biasing, load lines, small-signal analysis of single and multi-stage amplifiers, frequency response of BJT amplifiers. Field effect transistors (FET), principle of operation of JFET and MOSFET, Depletion and Enhancement type NMOS and PMOS, biasing of FETs, Low and High frequency models of FETs, Switching circuit using FETs, Introduction to CMOS. Operational amplifier (OPAMP), linear application of OPAMPs, gain, input and output impedances, differential amplifiers, common-mode rejection ratio, instrumentation amplifier, active filters, frequency response and noise, zero crossing, positive and negative level detectors, and application of Op-Amp.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** semiconductor devices' basic operation and characteristics like diodes, BJTs, and FETs.	3											
CO2	Be able to **apply** the established equivalent models to find the important ac parameters for an amplifier.	3											
CO3	Be able to **analyze** the DC and AC output response of a network designed with BJT and become acquainted with the BJT amplifiers' design process.		3										
CO4	Be able to **understand** the characteristics of Op-Amps and its applications.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for the final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Semiconductor devices**	
Lecture 1	Basic idea about Electronics, Examples of electronic devices, and comparison with electrical equipment's.	
Lecture 2	Introduction to semiconductor devices and its classifications, P-type and N-type materials, and doping	**CT – 1, Final**

Lecture 3	Semiconductor diode and its band diagram, Biasing of semiconductor diodes	
2	**Diodes**	
Lecture 4	I-V characteristics of the diode and equivalent circuit of diodes, Shockley's equation and related mathematical problems	
Lecture 5	Zener diode and related maths of Zener diode	
Lecture 6	Applications of diode	
3	**Diodes**	
Lecture 7	Diode rectifiers	
Lecture 8	Ripple factor, and related mathematical problems.	
Lecture 9	Clipper circuit and related problems, Clamper circuit and related problems	
4	**BJT**	**CT-2, Final**
Lecture 10	Introduction to BJT and construction	
Lecture 11	Working principle and operating regions of BJT, CB, CE, and CC configurations and characteristics curves	
Lecture 12	Mathematical problems related to different configurations using BJT	
5	**BJT**	
Lecture 13	BJT Biasing, Mathematical problems related to BJT biasing	
Lecture 14	Mathematical problems related to BJT biasing	
Lecture 15	Mathematical problems related to BJT biasing	
6	**BJT**	
Lecture 16	BJT as an amplifier, BJT as a switch, and biasing the BJT for discrete circuits	
Lecture 17	Small-signal analysis of single and multi-stage amplifiers	
Lecture 18	Voltage and current gain, input and output impedance of a common base configurations	
7	**BJT**	
Lecture 19	Voltage and current gain, input and output impedance of a common emitter configurations	
Lecture 20	Voltage and current gain, input and output impedance of a common collector configurations	
Lecture 21	The frequency response of BJT amplifiers	
Midterm Break		
8	**FET**	**Midterm**
Lecture 22	Introduction to FET and comparative studies between BJT and FET	
Lecture 23	Construction, operation, Drain characteristics, and Transfer characteristics of JFET	
Lecture 24	Pinch off voltage	
9	**FET**	
Lecture 25	Mathematical problems related to JFET	
Lecture 26	Introduction to MOSFET, construction, operation, input characteristics, output characteristics of depletion type MOSFET, and related mathematical problems.	
Lecture 27	Construction, operation, input characteristics, output characteristics of enhancement type MOSFET, and related mathematical problems	
10	**Biasing of FET**	

Lecture 28	Biasing of JFET and related problems	
Lecture 29	Biasing of MOSFET and related problems	
Lecture 30	Biasing of MOSFET and related problems	
11	**MOSFET**	**Final**
Lecture 31	Threshold voltage, Body effect, current-voltage characteristics of an enhancement MOSFET	
Lecture 32	Single-stage MOS amplifiers, MOSFET as a switch, CMOS inverter	
Lecture 33	Mathematical Problems	
12	**OP-AMP**	**CT – 3, Final**
Lecture 34	Introduction to Op-amp, Characteristics, Gain, Input and Output Impedances	
Lecture 35	Summing, Scaling, Averaging, and Subtractor Amplifiers	
Lecture 36	Differential Amplifiers, Differentiator, and Integrator	
13	**OP-AMP**	
Lecture 37	Common Mode Rejection Ratio (CMRR)	
Lecture 38	Active filters	**FINAL**
Lecture 39	Active filters	
14	**OP-AMP**	
Lecture 40	Instrumentation Amplifiers	
Lecture 41	Zero-Crossing Detector, Positive and Negative Voltage level detector	
Lecture 42	Other Applications of Op-Amp	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Electronic Device and Circuit Theory by Robert L. Boylestad
2. Op-amps and linear integrated circuits by Ramakant A Gayakwad

REFERENCE BOOKS

1. Operational Amplifiers and Linear Integrated Circuit – by Robert F. Coughlin and Frederic R. Driscoll.
2. Microelectronic Circuits Theory and Applications - by Adel S. Sedra and Kenneth C. Smith
3. Electronic Devices Circuits by Millman and Halkias

REFERENCE SITE

5.2.2.2 EECE 292 Electronic Circuits and Devices Sessional

COURSE INFORMATION			
Course Code Course Title	: EECE 292 : Electronic Devices and Circuits Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

EECE 291: Electronic Devices and Circuits

CURRICULUM STRUCTURE

Outcome-Based Education (OBE)

SYNOPSIS/RATIONALE

To learn and familiarize with the basics of electronic circuits and utilize electronic devices for practical purposes.

OBJECTIVE

1. To learn about electronic circuits and to implement the basic electronic devices circuits.
2. To know and use of BJT, MOSFET and JFET devices for theoretical and practical purposes.
3. To learn about operational amplifier and filter circuits.
4. To solve complex design problems regarding electronics based on realistic aspects.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** practically the basic electronic devices such as Diode, BJT, MOSFET, FET, and special electronic devices like operational amplifiers.	C2	2	1	-	1, 3	T, Q, R
CO2	Be able to **apply** the basic circuit components and know-how to connect them to make filters and other devices with amplifiers.	C3	1	1, 3	-	1, 2, 3	T, Q, R
CO3	Be able to **analyze** the concepts of electronic devices, circuits, and uses.	C4	2	1	-	1, 3	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Study of Diode Characteristics, Study of Diode Rectifier, Study of NPN CB (Common Base) Transistor Characteristics, Study of NPN CE (Common Emitter) Transistor Characteristics, Study of BJT Biasing Circuits, Study the Characteristics of JFET, MOSFET, Mathematical Operations Using Op-Amp, Active Filters, etc.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** practically the basic electronic devices such as Diode, BJT, MOSFET, FET, and special electronic devices like operational amplifiers.		3										
CO2	Be able to **apply** the basic circuit components and know-how to connect them to make filters and other devices with amplifiers.	3											
CO3	Be able to **analyze** the concepts of electronic devices, circuits, and uses.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for the final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	**Lecture Topics**	Assessment
1	Study of Diode Characteristics	Report, Lab Test, Quiz, Viva
2	Study of Diode Rectifier	
3	Study of CB (Common Base) Transistor Characteristics	
4	Study of CE (Common Emitter) Transistor Characteristics	
5	Study of BJT Biasing Circuits	
6	Study the Characteristics of JFET	
7	**Lab Test- 01 and Viva**	
	Midterm Break	
8	Study the Characteristics of MOSFET	Report, Lab Test, Quiz, Viva
9	Study of Inverting and Non- inverting operations using OP-AMP	
10	Mathematical operations using OP-AMP	
11	Design Active Filters using Op-Amp	
12	Design Differential Amplifiers using Op-Amp	

13	**Lab Test- 02 and Viva**	
14	Final Quiz	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Electronic Device and Circuit Theory by Robert L. Boylestad
2. Op-amps and linear integrated circuits by Ramakant A Gayakwad

REFERENCE BOOKS

3. Operational Amplifiers and Linear Integrated Circuit – by Robert F. Coughlin and Frederic R. Driscoll.

REFERENCE SITE

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5.2.3 Level-3, Spring

5.2.3.1 EECE 391 Digital Electronics

COURSE INFORMATION			
Course Code Course Title	: EECE 391 : Digital Electronics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE
EECE 291: Electronic Devices and Circuits
CURRICULUM STRUCTURE
Outcome-Based Education (OBE)
SYNOPSIS/RATIONALE
This course will cover the topics/subtopics that will help to learn and familiarize the fundamentals of digital electronics, including the basic logic gates, combinational and sequential circuits, Programmable logic devices, and Modular sequential logic circuit design.
OBJECTIVE
1. To acquire the basic knowledge of digital logic levels and knowledge to understand digital electronics circuits. 2. To prepare students for performing the analysis and design of various combinational and sequential circuits.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **remember** the structure of various number systems and its application in digital design.	C1	1	1	-	1,3	T, F
CO2	Be able to **understand** the design criterion of combinational and sequential logic circuits as needed.	C2	1	1,3	-	1,3	T, F
CO3	Be able to **apply** the logic gates to solve the real-world Problem of electronic circuits.	C3	2	1	-	1, 3	MID, F
CO4	Be able to **analyze** the memory elements, state table, and state diagrams of the sequential circuit.	C4	2	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to number systems and codes: Number base conversion, Complements, and related problems, Binary codes; Analysis and synthesis of digital logic circuits: Basic logic functions, Boolean algebra, combinational logic design, minimization of combinational logic. Implementation of basic static logic gates in CMOS and BiCMOS: DC characteristics, noise margin, and power dissipation. Power optimization of basic gates and combinational logic circuits. Modular combinational circuit design: Pass transistor, pass gates, multiplexer, demultiplexer, and their implementation in CMOS, decoder, encoder, comparators, binary arithmetic elements, and ALU design. Programmable logic devices: Logic arrays, field programmable logic arrays, and programmable read-only memory. Sequential circuits:

Different types of latches, SR flip-flops, master-slave, JK flip-flops, T & D flip-flops, Flip-flops design using ASM approach, Timing analysis, and power optimization of sequential circuits. Modular sequential logic circuit design:

Shift registers, Parallel I/O and Series I/O shift registers, Universal shift register, Counters: Introduction, Asynchronous and Synchronous counters: up and down, BCD counters, Ring counter, Johnson counter. Applications of registers and counters.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **remember** the structure of various number systems and its application in digital design.	3											
CO2	Be able to **understand** the design criterion of combinational and sequential logic circuits as needed.	3											
CO3	Be able to **apply** the logic gates to solve the real-world Problem of electronic circuits.		3										
CO4	Be able to **analyze** the memory elements, state table, and state diagrams of the sequential circuit.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to number systems and codes**	**CT – 1, Final**
Lecture 1	Number base conversion	
Lecture 2	Complements and related problems	
Lecture 3	Binary codes	
2	**Analysis and synthesis of digital logic circuits**	
Lecture 4	Basic logic functions	
Lecture 5	Boolean algebra	
Lecture 6	Boolean algebra	
3	**Analysis and synthesis of digital logic circuits**	
Lecture 7	Combinational logic design	
Lecture 8	Combinational logic design	

Lecture 9	Minimization of combinational logic	
4	**Implementation of basic static logic gates in CMOS and BiCMOS**	**Midterm, Final**
Lecture 10	DC characteristics, noise margin, and power dissipation	
Lecture 11	Power optimization of basic gates	
Lecture 12	Combinational logic circuits	
5	**Modular combinational circuit design**	
Lecture 13	Pass transistor, Pass gates	
Lecture 14	Multiplexer	
Lecture 15	Demultiplexer	
6	**Modular combinational circuit design**	
Lecture 16	Implementation of multiplexer and demultiplexer in CMOS	
Lecture 17	Decoder	
Lecture 18	Encoder	
7	**Modular combinational circuit design**	
Lecture 19	Comparators	
Lecture 20	Binary arithmetic elements and ALU design	
Lecture 21	Binary arithmetic elements and ALU design	
	Midterm Break	
8	**Programmable logic devices**	**CT – 2, Final**
Lecture 22	Logic arrays	
Lecture 23	Field programmable logic arrays	
Lecture 24	Programmable read-only memory	
9	**Sequential Circuits**	
Lecture 25	Different types of latches	
Lecture 26	SR flip-flops, master-slave	
Lecture 27	JK flip-flops	
10	**Sequential Circuits**	
Lecture 28	T & D flip-flops	
Lecture 29	Flip-flops design using the ASM approach	
Lecture 30	Timing analysis and power optimization of sequential circuits	
11	**Modular sequential logic circuit design**	**CT – 3, FINAL**
Lecture 31	Shift registers	
Lecture 32	Parallel I/O shift registers.	
Lecture 33	Series I/O shift registers and	
12	**Modular sequential logic circuit design**	
Lecture 34	Universal shift register	
Lecture 35	Counters: Introduction	
Lecture 36	Asynchronous counters: up and down	
13	**Modular sequential logic circuit design**	**FINAL**
Lecture 37	Synchronous counters: up and down	
Lecture 38	BCD counters	
Lecture 39	Ring counter	
14	**Application of sequential logic circuits**	
Lecture 40	Johnson counter	
Lecture 41	Applications of registers	
Lecture 42	Applications of counters	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

Digital Electronics:

1. M. Morris Mano and Michael D. Ciletti, Digital Design, 6th Edition, 20108. ISBN -10: 0-07-147217-7

REFERENCE BOOKS

2. S Salivahanan and S Arivazhagan, Digital Electronics, 2011.

REFERENCE SITE

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5.2.3.2 EECE 392 Digital Electronics Sessional

COURSE INFORMATION			
Course Code Course Title	: EECE 392 : Digital Electronics Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: EECE 295

Course Title: Digital Electronics

CURRICULUM STRUCTURE

Outcome-Based Education (OBE)

SYNOPSIS/RATIONALE

To learn and familiarize with the basics of digital electronic circuits and utilize digital electronic circuits for practical purposes.

OBJECTIVE

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EECE 391. In the second part, students will design simple systems using the principles learned in EECE 391.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** the knowledge of basic digital electronic circuits practically.	C3	2	1	-	1, 3	T, Q, R
CO2	Be able to **analyze** and **evaluate** the necessity and utilization of different types of logic and sequential circuits for real problems.	C4, C5	2, 5	1, 3	-	1, 2, 3	T, Q, R, ASG
CO3	Be able to **create** different digital circuits with ICs to use for our day to day necessities.	C6	5, 9	1	-	1, 3	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Familiarization and use of truth table of basic logic Gates, De Morgan's law, Digital logic circuit and its simplification using Boolean algebra, Adder & subtractor circuits, Encoder and Decoder circuits, BCD to seven-segment decoder circuit, Multiplexer & de-multiplexer, Flip-flop circuits, Up and down counters.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to apply the knowledge of basic digital electronic circuits practically.		3										
CO2	Be able to analyze and evaluate the necessity and utilization of different types of logic and sequential circuits for real problems.		3			3							
CO3	Be able to create different digital circuits with ICs to use for our day to day necessities.		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Familiarization and use of truth table of basic logic Gates	Report, Assignment, Lab Test, Viva
2	Verification of De Morgan's laws using the logic gates	
3	Implementing the truth tables of a digital logic circuit and its simplification using Boolean algebra	
4	Design of adder & subtractor circuits using basic gates	
5	Design and implement of encoder and decoder circuits	

6	Design and implement of BCD to seven-segment decoder circuit using logic gates	
7	Lab Test with Viva-01	
	Midterm Break	
8	Design and implement of multiplexer circuit using logic gates	Report, Lab Test, Quiz, Viva
9	Design and implement of the de-multiplexer circuit using logic gates	
10	Design and implement various types of clocked flip-flop circuits using logic gates	
11	Design and implement of up and down counters	
12	Quiz test	
13	Lab Test-02	
14	Final Viva with Reports	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Digital Logic and Computer Design- M Morris Mano; Prentice Hall of India Private Ltd

REFERENCE BOOKS

1. Digital Fundamentals - F Loyd; Prentice-Hall International, Inc
2. Pulse, Digital and Switching waveforms - Jacob Millman& Herbert Taub; Tata McGraw- Hill

REFERENCE SITE

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5.3 Department of Computer Science and Engineering

5.3.1 Level-2, Spring

5.3.1.1 CSE 291 Computer Programming

COURSE INFORMATION							
Course Code Course Title	: CSE 291 : Computer Programming		Lecture Contact Hours Credit Hours	: 3.00 : 3.00			
PRE-REQUISITE							
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CURRICULUM STRUCTURE							
Outcome Based Education (OBE)							
SYNOPSIS/RATIONALE							
To introduce with the most recent technology and to teach students the basic concepts of computer programming.							
OBJECTIVE							
1. To have basic idea about computer organization 2. To understand the basics of computer programming in C/C++. 3. To learn how to think about the problems, their solutions and translating it to programming							
LEARNING OUTCOMES& GENERIC SKILLS							
No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods	
CO1	**Be able to explain** the difference between object oriented programming language and procedural language	C1,C2	1	-	1	T, ASG	
CO2	**Be able to apply** C/C++ features such as composition of structures, objects, operator overloading, inheritance, polymorphism etc.	C3, C4	3	-	3	MT, F	
CO3	**Be able to evaluate** the relative merits of different algorithm to solve and design programming constructs for real world problems	C5,C6	4	-	2, 5	Pr, F	
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Midterm Exam)							
COURSE CONTENT							
Fundamentals of computer; Major components of a computer: processor, memory, I/O devices, operating systems; Basic Programming Concepts: object, source, executable code; Program development stages: algorithms and flow charts; Number system: binary, octal, decimal and hexadecimal systems; Structured Programming using C: data types, variables and constants, operators, expressions, control statements: "if else", "switch"; Loop, function, arrays, strings, pointers, and user defined data types: structure, unions; Input output and files. Object oriented Programming using C++: philosophy of object oriented programming (OOP), advantages of							

OOP over structured programming, classes and objects, access specifiers, static and non-static members, Array of objects, constructors, destructors, copy constructor, abstraction, encapsulation, polymorphism: operator overloading, abstract classes, virtual functions, overriding; inheritance: single and multiple inheritance.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Be able to explain** the difference between object oriented programming language and procedural language	3											
CO2	**Be able to apply** C/C++ features such as composition of structures, objects, operator overloading, inheritance, polymorphism etc.		3										
CO3	**Be able to evaluate** the relative merits of different algorithm to solve and design programming constructs for real world problems		2	3							2		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1-PO1	High	Achieving in-depth of knowledge on programming concepts and the features of a programming languages.
CO2-PO2	High	Developing the skill of analysis to execute proper programming concepts to solve a problem.
CO3-PO2	Medium	Analysing a problem to find an appropriate solution.
CO3-PO3	High	Designing valid algorithm and solve the real life problems using specified programming language.
CO3-PO10	Medium	Through presentation, the communication skills will be developed.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	64
Revision	-
Assessment Preparations	20
Formal Assessment	
Continuous Assessment	3
Final Examination	3
Total	132

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Lecture	Topics	
1	Lec 1 Lec 2 Lec 3	Programming Concepts, Program development Stages, Structured programming language	
2	Lec 4 Lec 5 Lec 6	Number Systems, Data types and their memory allocation, Variables, Operators	
3	Lec 7 Lec 8 Lec 9	Expressions, Basic Input/output; Control Structure	**Class Test 1**
4	Lec 10 Lec 11 Lec 12	Control structures: loop, While loop	
5	Lec 13 Lec 14 Lec 15	Nested loop, Functions	
6	Lec 16 Lec 17 Lec 18	Arrays: Single, Multi-dimensional arrays	**Class Test 2**
7	Lec 19 Lec 20 Lec 21	Strings	
8	Lec 22 Lec 23 Lec 24	Pointers	
9	Lec 25 Lec 26 Lec 27	User defined data types: Structure, unions Input output and files	**Class Test 3**
10	Lec 31 Lec 32 Lec 33	Object oriented Programming using C++: Introduction	
11	Lec 28 Lec 29 Lec 30	Classes and objects, Array of objects, Access specifiers	
12	Lec 34 Lec 35 Lec 36	Constructors, Abstraction, Encapsulation	
13	Lec 37 Lec 38 Lec 39	Polymorphism Function and operator overloading	**Midterm / Project**
14	Lec 40 Lec 41 Lec 42	Inheritance	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Test 1-3	20%	CO 1	C1, C2
	Presentation	5%	CO 3	C5, C6
	Midterm	15%	CO 2	C3, C4
Final Exam		60%	CO 2	C3- C6
			CO 3	
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Teach Yourself C - Herbert Schidlt

REFERENCE BOOKS

1. Programming with C - John Hubbard; Schaum"s Outlines.
2. Programming with C++ - John Hubbard; McGraw-Hill Int. Edn
3. Teach Yourself C++ -- Herbert Schildt

REFERENCE SITE

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5.3.1.2 CSE 292 Computer Programming Sessional

COURSE INFORMATION			
Course Code Course Title	: CSE 192 : Computer Programming Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE
Course Code: CSE 291 Course Title: Computer Programming
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
To introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development.
OBJECTIVE
1. To learn basic idea of programming languages. 2. To learn how to program with C/C++. 3. To learn how to think about the problems, their solutions and translating it to programming language.
LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **practice** structured programming language and design algorithm for problems	C1, C2, A1, A2	-	2	1, 3	PR, T, Q
CO2	Be able to **apply** practical knowledge to develop basic programming skills with respect to program design and development	C3, C4, C6	-	3	2, 3, 6	F, T, ASG
CO3	Be able to **demonstrate** good programming style and discuss the impact of style on developing and maintaining programs	C4, C6, P6	-	5	4, 5	Q, ASG, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

COURSE CONTENT

Programming concepts, Codeblocks IDE, Input and Output: Standard input and output, Formatted input and output, Data Types, Basic Knowledge: Mathematical problems using printf, scanf, Operators, If, Else if, Switch, Loop, Nested Loop (for loop, while loop, do-while loop), function, arrays, pointers, structure unions. User defined data types. Input output and files. Object oriented Programming using C++: philosophy of object oriented programming (OOP), advantages of OOP over structured programming, classes and objects, access specifiers, static and non-static members, Array of objects, constructors, destructors, copy constructor, abstraction, encapsulation, polymorphism: operator overloading, abstract classes, virtual functions, overriding; inheritance: single and multiple inheritance.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **practice** structured programming language and design algorithm for problems				1						2		3
CO2	Be able to **apply** practical knowledge to develop basic programming skills with respect to program design and development	3		3						3			
CO3	Be able to **demonstrate** good programming style and discuss the impact of style on developing and maintaining programs		3			2							

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Level	Justifications
CO1-PO4	Low	For preparing valid algorithm, depth of investigation and experimentation is required
CO1-CO10	Medium	Through presentation, the communication skills will be developed.
CO1-PO12	High	Project submission will help to develop skill which will be beneficial for life time.
CO2-PO1	High	Achieving in-depth of knowledge on programming concepts and the features of a programming languages.
CO2-PO3	High	Developing and designing a proper solution for various problems
CO2-PO9	High	Group assignment will help to develop team coordination
CO3-PO2	High	In the process of maintaining programs intensive analysis skill will be achieved
CO3-PO5	Medium	For demonstrating good style modern tool usage would be must

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	-
Practical / Tutorial / Studio	63
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision	-
Assessment Preparations	-
Formal Assessment	
Continuous Assessment	4
Final Examination (online)	1.5 X 2=3
Total	70

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week	Topics
1	Basic I/O, Solving Mathematical problems, operators
2	If, Else if, Switch
3	Loop
4	Array, 2D Array
5	Function
6	Pointers
7	**Online-1**
8	User Defined Data Types: Structures, Unions
9	OOP Introduction, classes and objects, access specifiers (using C++)
10	Constructors, Destructors, Encapsulation
11	Polymorphism
12	Inheritance
13	**Quiz, Project Submission**
14	**Online-2**

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy
Quiz	10%	CO 1, CO 3	C1,C2, C4, C6, A1, A2, P6
Project	20%	CO 1	C1,C2 A1-A2
Class Performance (T)	20%	CO1, CO 2,	C1-C4, C6, A1-A2
Online Test-1 (F)	20%	CO 2, CO 3	C3, C4, C6, P6
Online Test-2 (F)	20%	CO 2, CO 3	C3, C4, C6, P6
Assignment	10%	CO 2, CO 3	C3, C4, C6, P6
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Teach Yourself C - Herbert Schidlt
2. Programming with C - John Hubbard; Schaum‟s Outlines.

REFERENCE BOOKS

1. Programming with C++ - John Hubbard; McGraw-Hill Int. Edn.
2. Teach Yourself C++ - Herbert Schidlt
3. Sober Jonno Computer Programming Language C- Md Kamruzzaman Niton

5.4 Department of Mechanical Engineering

5.4.1 Level-2, Fall

5.4.1.1 ME 291 Principles of Mechanical Engineering

COURSE INFORMATION			
Course Code Course Title	: ME 291 : Principles of Mechanical Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
NA			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The main aim of this course is to introduce the students of biomedical engineering to basic concepts in mechanical engineering. These principles and concepts will be later used in courses in biomedical engineering ranging from biomechanics, biomaterials, biofluid mechanics, robotics and artificial organ development			
OBJECTIVE			
1. Be able to understand the basic concepts in solid mechanics **2.** Be able to apply the concepts of solid mechanics to machine design and analysis **3.** Be able to describe basic laws of thermodynamics with their applications **4.** Be able to appreciate different control system used in robotics and automation industry			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basic concepts in solid mechanics	C2	1	-	-	1	T, MID, F
CO2	Be able to **describe** basic laws of thermodynamics with their applications	C2	1	-	1	1	T,F
CO3	Be able to **appreciate** different control system using in robotics and automation industry	C2	1,2	1	1	1	T,F
CO4	Be able to **apply** the concepts of solid mechanics to machine design and analysis	C3	2	1	1	1	T, MID, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The course covers basic theory in statics and solid mechanics including stress-strain analysis, bending, torsion, and different types of mechanical testing. These tests are discussed in the lights of machine design and analysis. Emphasis is given on machine failure. The syllabus further includes fundamental concepts of thermodynamics and thermal physics and control theory used in robotics and automation applications.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basic concepts in solid mechanics	3											
CO2	Be able to **describe** basic laws of thermodynamics with their applications	3											
CO3	Be able to **appreciate** different control system used in robotics and automation industry	3	2										
CO4	Be able to **apply** the concepts of solid mechanics to machine design and analysis		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Introduction & Statics**	**CT – 1 and Midterm, Final**
Lecture 1	Introduction to Mechanical Engineering for Biomedical Engineers	
Lecture 2	Fundamentals of statics: Force, Moments, Static equilibrium	
Lecture 3	Stress: Normal and Shear stresses	
2	**Statics**	
Lecture 4	Strain: Normal and Shear strains	
Lecture 5	Hooke’s Law for linear elastic material, Young’ Modulus	
Lecture 6	Poisson’s ratio and Bulk Modulus	
3	**Stress-strain relationship and Mohr’s Circle**	
Lecture 7	Stress-strain relationship of materials	
Lecture 8	Stress Transformations and principal stresses	
Lecture 9	Introduction to Mohr’s Circle	
4	**Introduction to beams and support**	

Lecture 10	Beams and support	
Lecture 11	Shear and bending moment diagrams	
Lecture 12	3 point bending test, Normal stresses in beams	
5	**Bending and stress analysis**	**Midterm, Final**
Lecture 13	4 point bending tests	
Lecture 14	Moment of inertia	
Lecture 15	Stress analysis, Stresses in curved members	
6	**Mechanical Design**	
Lecture 16	Pressure vessels	
Lecture 17	Column design and coupling	
Lecture 18	Shock and Impact	
7	**Machine Design**	
Lecture 19	Fracture, fatigue and failure modes	
Lecture 20	Failure analysis and safety consideration	
Lecture 21	Revision	
MIDTERM		
8	**Introduction to Thermodynamics**	**CT – 2, FINAL**
Lecture 22	Kinetic theory of gases and Maxwell's distribution of molecular speeds	
Lecture 23	Mean free path, Brownian motion, Van Der Waal's equation of state	
Lecture 24	First Law of thermodynamics and its applications, Reversible and irreversible processes	
9	**Second law of thermodynamics**	
Lecture 25	Second Law of thermodynamics and its applications	
Lecture 26	Entropy and disorder	
Lecture 27	Carnot's cycle and Carnot's theorem	
10	**Heat engines, AC and refrigeration**	
Lecture 28	Efficiency of heat engines. Thermodynamic functions	
Lecture 29	Refrigeration and AC cycles	
Lecture 30	Humidity control, HVAC systems	
11	**Control systems**	**CT – 3, FINAL**
Lecture 31	Introduction to control systems and engineering, Modelling of basic feedback systems	
Lecture 32	Simulation of basic feedback loop-based control systems	
Lecture 33	Block Diagrams and Transfer Functions for Control Systems	
12	**Controller design and stability analysis**	
Lecture 34	Design of PID controllers	
Lecture 35	Design of PLC controllers	
Lecture 36	Stability and Robustness of controllers	
13	**Robotics and mechatronics**	**FINAL**
Lecture 37	Mechanics of linkage systems	
Lecture 38	Basic Cartesian and rotational robots	
Lecture 39	Hydraulics and pneumatics powered artificial muscles	
14	**Robotics and mechatronics**	
Lecture 40	Automation and frequency response	
Lecture 41	Mechatronics subsystems: sensors and actuators, Signal analysis and control	
Lecture 42	Modelling of dynamic mechatronic systems	
FINAL EXAMINATION		

ASSESSMENT STRATEGY				
Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4	C2, C3
	Class Participation/ Assignment	5%	CO1, CO2, CO3, CO4	C2, C3
	Midterm	15%	CO1, CO2	C2, C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Introduction to Mechanical Engineering, Part 1, Hodder Education UK, 2009

REFERENCE BOOKS

1. Introduction to Mechanical Engineering, Part 2, Hodder Education UK, 2009

REFERENCE SITE

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CHAPTER 6
COURSE OFFERED BY BME DEPARTMENT

6.1 Core Course Offered

6.1.1 BME 101 Introduction to Biomedical Engineering

COURSE INFORMATION			
Course Code Course Title	: BME 101 : Introduction to Biomedical Engineering	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
PRE-REQUISITE			
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CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The course covers the following modules: Introduction to Biomedical Engineering, Basic Life Science, Biotechnology, Biomaterials, Tissue Engineering, Drug Development and Delivery, Nanotechnology, Biomechanics, Biomedical Implants and Braces, Biosignals, Bioinstrumentation, BioMEMs and biosensors, Biomedical Imaging, Biomedical Image processing, Computational Biology.			
OBJECTIVE			
1. Distinguish and identify key fields and research domains in the field of BME. 2. Understand the role of Biomedical Engineers in healthcare and society as a whole. 3. Understand how the development of biomedical technology, devices and instrumentation can enhance the quality and precision of healthcare for disease diagnosis, treatment, and prevention.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the role of Biomedical Engineers in healthcare and society as a whole	C2	1, 6	-	-	-	T, MID, F
CO2	Be able to **identify** key fields and research domains in the field of BME	C2	1	-	-	-	MID, F
CO3	Be able to **analyze** how the development of biomedical technology, devices and instrumentation can enhance the quality and precision of healthcare for disease diagnosis, treatment, and prevention	C4	2	-	-	-	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 – Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

Introduction to Biomedical Engineering, Basic Life Science, Biotechnology, Biomaterials, Tissue Engineering, Drug Development and Delivery, Nanotechnology, Biomechanics, Biomedical Implants and Braces, Biosignals, Bioinstrumentation, BioMEMs and biosensors, Biomedical Imaging, Biomedical Image processing, Computational Biology.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the role of Biomedical Engineers in healthcare and society as a whole	3					3						
CO2	Be able to **identify** key fields and research domains in the field of BME	3											
CO3	Be able to **analyze** how the development of biomedical technology, devices and instrumentation can enhance the quality and precision of healthcare for disease diagnosis, treatment, and prevention		2										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	28
Revision of the previous and (or) subsequent lecture at home	14
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	89

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Weeks	Topics	Assessment
1	**Introduction to Biomedical Engineering**	CT – 1 and Midterm, Final
Lecture 1	Motivation Course and Introduction	
Lecture 2	Careers in Biomedical Engineering, Current and Future Trends of Biomedical Engineering: Bangladesh and International Perspective	
2	**Introduction to Biomedical Engineering**	
Lecture 3	Different fields of Biomedical Engineering, Guide to choosing a major to specialize	
Lecture 4	Biomedical research facilities and institutions: Bangladesh and International perspective, Societies, Websites	
3	**Basic Life Science**	
Lecture 5	Introduction to the Chemical basis of life Introductory Biochemistry	
Lecture 6	Introduction to nucleic acids and genes Fundamentals of Molecular Biology	
4	**Biotechnology**	
Lecture 7	Introduction to Biotechnology in BME, Examples of DNA, RNA & protein technology and biomedical applications,	
Lecture 8	Introductory Genetic Engineering, Advances in Genetic Engineering in BME applications	
5	**Biomaterials**	Midterm, Final
Lecture 9	Introduction to material science in Biomedical Engineering Definition and types of Biomaterials	
Lecture 10	Biocompatibility: Why is it important? Examples and applications of Biomaterials	
6	**Tissue Engineering**	
Lecture 11	Introduction to cell and tissue engineering and regenerative medicine Applications of Tissue Engineering	
Lecture 12	Functional Tissue Engineering Recent advances and future trends in Tissue Engineering and Regenerative Medicine	
7	**Drug Development and Delivery, Nanotechnology**	
Lecture 13	Introduction to Drug Development and Delivery Definitions of Pharmaceuticals and pharmacokinetics	
Lecture 14	Introduction to Nanotechnology Nanotechnology in biomedicine Nanomaterials used in BME: Examples and Application	
	MIDTERM	
8	**Biomechanics, Biomedical Implants and Braces**	CT – 2, FINAL
Lecture 15	Definition of Biomechanics Classification of Biomechanics Branches and application of Biomechanics	
Lecture 16	Introduction to implants and braces Different types of Medical Braces	
9	**Biosignals**	
Lecture 17	Physiological origins of biosignals Different signals generated in the human body Bioelectric phenomena	
Lecture 18	Basic Bioinstrumentation Common Equipment used in medical facilities	
10	**Bioinstrumentation**	
Lecture 19	Introduction to Sensors, Transducers and Actuators Introduction to Biomedical sensors	

	Examples of Biosensors	
Lecture 20	Different types of biosensors Applications of biosensors	
11	**BioMEMs and biosensors, Biomedical Imaging**	**CT – 3, FINAL**
Lecture 21	Introduction to MEMs and BioMEMs BioMEMs applications and advances	
Lecture 22	Introduction to Biomedical Imaging Common medical imaging modalities: X-ray, CT-scan, MRI, Ultrasound, Nuclear Medicine (SPECT & PET)	
12	**Biomedical Image processing and Computational Biology**	
Lecture 23	Introduction to Image processing The importance of image processing in diagnostics Examples of biomedical image processing	
Lecture 24	Introduction to Bioinformatics and Biostatistics Examples of Computational Biology in BME applications	
13	**Biomedical Optics and Lasers, Telemedicine**	
Lecture 25	Introduction to Optics in BME Application of optics in BME	
Lecture 26	Introduction to telehealth or e-health Importance of Telemedicine	
14	**Review Week**	**-**
Lecture 27	Review Class	
Lecture 28	Review Class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C4
	Class Participation	5%	CO2	C2
	Midterm	15%	CO1, CO2	C1, C2
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Introduction to Biomedical Engineering, John D. Enderle, Joseph D. Bronzino.

REFERENCE SITE

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6.1.2 BME 104 CAD in Biomedical Engineering Sessional

COURSE INFORMATION

Course Code Course Title	: BME 104 : CAD in Biomedical Engineering Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

In this course, students will be taught the designing of 3D models with printed porotypes of devices and equipment for biomedical engineering applications using software packages.

OBJECTIVE

This course aims to introduce students to 3D drafting and modeling techniques in the context of biomedical engineering.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **draw** 3D parts and assemblies according to technical specifications with realistic constraints.	C6	1, 5	-	-	5	T, Q, R,ASG
CO2	Be able to **make** 3D printed models following specified design requirements.	C6	1,2	-	1	5	PR, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 – Create

COURSE CONTENT

Fundamental concepts of Orthographic views, 3D Isometric view, Isometric projection from orthographic views. Introduction to 2D drafting, Draw a 2D sketch of the isometric views of a complex structure, Converting 2D sketch to 3D bodies using extrude and revolve features, Generate the 3D part of a dental abutment, Make threads using the helix and spirals, and swept base/boss features, Generate the 3D part of a dental screw, Generation of planes at angles using sketches and surfaces as references, Create the model of a dynamic hip screw using the given dimensions of its cross-sections, Create complex thin models using surface tools boundary, trim, and thicken, Design a bone plate, Design and assemble the components of total hip implant part 1: Femoral hip stem and head, Design and assemble the components of total hip implant part 2: Polyethylene liner and Acetabular shell, and their assembly, Introduction to 3D printing technology, Development of a 3D printed prototype model of a biological structure.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **design** 3D parts and assemblies according to technical specifications with realistic constrains.	3				3							
CO2	Be able to **create** 3D printed models following specified design requirements.	3	3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35

Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	10
Preparation for final examination	14
Formal Assessment	
Continuous Assessment	1
Presentation	0.25
Lab Test	2
Quiz	0.5
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Fundamental concepts of Orthographic views, 3D Isometric view, Isometric projection from orthographic views, and 2D drafting.	Report, Assignment, Lab Test, Quiz, Viva
2	Draw orthographic views from the isometric view of complex structures. Draw isometric views from orthographic views of complex structures.	
3	Converting 2D sketch to 3D bodies using extrude and revolve features. Generate the 3D part of a dental abutment.	
4	Make threads using the helix and spirals, and swept base/boss features. Generate the 3D part of a dental screw.	
5	Generation of planes at angles using sketches and surfaces as references.	
6	Create the model of a dynamic hip screw using the given dimensions of its cross-sections.	
7	Mid Lab Test	
	Midterm Break	
8	Create complex thin models using surface tools boundary, trim, and thicken. Design a bone plate.	Report, Assignment, Lab Test, Quiz, Viva
9	Design and assemble the components of total hip implant part 1: Femoral hip stem and head.	
10	Design and assemble the components of total hip implant part 2: Polyethylene liner and Acetabular shell, and their assembly.	
11	Introduction to 3D printing technology, familiarization with slicing software, 3D printing prototype of a biological structure.	Project, Presentation
12	3D Printed Final Project Presentation	
13	Final Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (20%)	Report/ Assignment	10%	CO1, CO2	C6
	Class Participation	10%	CO1, CO2	C6
Final Exam (80%)	Lab Tests	40%	CO1, CO2	C6
	Project	20%	CO2	C6
	Quiz	10%	CO1, CO2	C6
	Viva	10%	CO1, CO2	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

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REFERENCE SITE

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6.1.3 BME 105 Human Anatomy

COURSE INFORMATION

Course Code Course Title	: BME 105 : Human Anatomy	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers cells, tissues, organization and functions of tissues and organs of different physiological systems, organ damage and automated repairing system. Learning objectives will be achieved through a combination of lectures. In addition, students will participate in small group discussions of clinical case studies, make group presentations of topic appropriate biomedical devices, and prepare a term paper on the subject of their choice selected from a list of topics generated by the instructor.

OBJECTIVE

1. To provide a foundation in human anatomy appropriate for students of biomedical engineering
2. To analyze the structural composition of the human body from cellular to organ levels

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **describe** the biochemical and structural organization of the body	C2	1	-	-	1	T, MID, F
CO2	Be able to **understand** the functions of the main organs of the body	C2	1	-	-	1	T, MID, F

CO3	Be able to **understand** some basic pathologies and how they affect the function of the body	C2	3	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Human cell: Structure of cell. Structure and functions of cell membrane and nucleus. Types of cellular organelles. Structure and functions of each organelle; Tissues: Types of tissues with their functions; Skeletal System: Components. Exoskeleton/endoskeleton. Bones of axial and appendicular skeleton. Organic and inorganic composition of bone. Functions of each composition. Effect of loss of Organic and inorganic composition. Classification of bones with example. Bones of different regions of the body. Functions of bone/skeleton Types of cartilage with example and functions; Joints: Definition, Classification of joints. Characteristic features of each type with example. Joints of thorax, upper limb, lower limb, Head-neck, vertebral column with types. Line of gravity. Weight transmission through the body; Muscle: Characteristic features and Functions of different types of muscles .Classification of skeletal muscles with example. Regional muscles: characteristic features and action of important muscle such as deltoid ,biceps brachii, triceps, rectus abdominis, gluteal muscles, calf muscles .muscles of back of the trunk; Mediastinum: Definition, Division , contents of mediastinum; Circulatory System: types and characteristic features of each type of circulation; Cardiovascular system: parts and functions of cardiovascular system. Gross feature of pericardium, pericardial sac and heart. Conducting system of heart: location and functions; Lymphatic system: Parts and functions of lymphatic system; Respiratory System: Parts of different zones of respiratory tract. Gross features and functions of pleura and lungs. Differences between right and left principal bronchus. Structure and functions of respiratory membrane. Muscles of respiration; Digestive System: Parts of digestive system. Extension, termination and constrictions of oesophagus. Gross features and functions of different parts of digestive system. Gross features and functions of liver and pancreas. Parts of extra hepatic biliary apparatus; Urinary System: parts of urinary system. Gross features and functions of different parts of urinary system; Reproductive System: Parts of Female and male reproductive system and their functions; Nervous System: Brain: different parts of brain and their functions. Spinal cord: beginning, termination and supports. Cranial nerves: motor, sensory and mixed cranial nerves; Meninges: Different parts of meninges, spaces between. the meninges with their contents; Cavities/ canals: contents of thoracic cavity, abdominal cavity, pelvic cavity, cranial cavity, orbit, vertebral canal; Ear: different parts of ear with their functions; Eye Ball: parts and functions of different layers of eyeball .Refractive media of eyeball; Integumentary System: Parts and functions of skin and skin appendages; Endocrine gland: definition, location, secretion and functions of endocrine glands. Differences between exocrine and endocrine glands.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **describe** the biochemical and structural organization of the body	3											
CO2	Be able to **understand** the functions of the main organs of the body	3											
CO3	Be able to **understand** some basic pathologies and how they affect the function of the body			2									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Course introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Introduction to Anatomy	
Lecture 2	Introduction to Living cells	
Lecture 3	Human cell: type, composition, Cell membrane.	
2	**Cell Biology**	
Lecture 4	Nucleus Chromosome & abnormalities.	
Lecture 5	DNA, RNA, Gene	
Lecture 6	Organelles-Type, Mitochondria, ER, Golgi, Lysosome	
3		
Lecture 7	Ribosome Cytoskeleton inclusions.	
	Tissues	
Lecture 8	Types of tissues with their functions, Epithelial tissue.	
Lecture 9	Connective tissue.	
4	**Skeletal system**	**Midterm, Final**
Lecture 10	Components, types, Bones of axial & appendicular skeleton. **Bones**- features, classification, composition, blood supply function. Bones of different regions of the body.	
Lecture 11	Cartilage: features, types, distributions.	
Lecture 12	Joint: Definition, Classification, Example of joints in different regions, stability of the joint.	
5	**Muscular system**	
Lecture 13	Types of muscles, Skeletal muscle.	
Lecture 14	Smooth & cardiac muscle.	
Lecture 15	Regional muscles: features & action	
6	**CVS**	

Lecture 16	Mediastinum	
Lecture 17	Cardiovascular system.	
Lecture 18	Features of pericardium sac, Heart, Conducting system of heart.	
7	**Respiratory system.**	
Lecture 19	Parts of respiratory system, Trachea, Bronchus, Bronchial tree, Respiratory membrane, RDS.	
Lecture 20	Lungs, pleura, respiratory muscles.	
	Lymphatic system	
Lecture 21	Parts, functions, lymph nodes, spleen, lymphatic vessels.	
MIDTERM		
8	**Digestive system**	**CT – 2, FINAL**
Lecture 22	Parts, extension, features, Oesophagus, Stomach, Intestine.	
Lecture 23	Liver, Biliary apparatus.	
Lecture 24	Pancreas, Digestive glands.	
9	**Urinary system**	
Lecture 25	Parts, kidney.	
Lecture 26	Ureter, Urinary bladder, Urethra.	
	Reproductive system	
Lecture 27	Male genital system	
10		
Lecture 28	Female genital system.	
	Nervous system	
Lecture 29	Brain - Parts	
Lecture 30	Meninges, Spinal cord.	
11		
Lecture 31	Cranial nerves. (1-6)	
Lecture 32	Cranial nerves. (7-12)	
Lecture 33	Spinal nerves, Autonomic nervous system.	
12	**Cavities/Canals of the body**	**CT – 3, FINAL**
Lecture 34	Thoracic, abdominal & pelvic cavities.	
Lecture 35	Cranial cavity. Orbit, vertebral canal.	
	Integumentary system.	
Lecture 36	Skin	
13	**Glands**	
Lecture 37	Exocrine glands	
Lecture 38	Thyroid & parathyroid glands	
Lecture 39	Pituitary glands	
14	**Sensory organs**	
Lecture 40	Eye	
Lecture 41	Nose	
Lecture 42	Ear	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3	C2
	Class Participation	5%	CO2	C2
	Midterm	15%	CO1, CO2	C2
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Essentials of Anatomy and physiology, by Valerie C. Scanlon and Tina Sanders.
2. Seeley's Essentials of Anatomy and physiology, by Cinnamone Vanputte, Jennifer Regan, Andrew Russo

REFERENCE BOOKS

Essentials of Human Anatomy Vol-1, 2, 3. A.k.Datta.

REFERENCE SITE

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6.1.4 BME 201 Human Physiology

COURSE INFORMATION

Course Code Course Title	: BME 201 : Human Physiology	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 105 – Human Anatomy

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers cell, tissues, homeostasis, functions of different physiological systems and their neural and hormonal regulation, contribution to disease development when these physiological functions are dysregulated.

OBJECTIVE

1. To introduce students to a systems approach to the normal physiological processes of the body to maintain homeostasis
2. To provide the foundation of information which will allow an increased understanding of the changes seen in pathological states studied further throughout the program
3. Biomedical engineers need to prepare their minds for analyzing, quantifying, thinking, and solving problems at the interface of engineering, medicine and biology. This course sets the basic concepts for future interfacing between engineering and physiology.

COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the functions of the main organs of the body	C2	1	-	-	1	T, MID, F
CO2	Be able to **understand** some basic pathologies and how they affect the function of the body	C2, C4	1	-	-	1	T, MID, F
CO3	Be able to **explain** and **analyze** the interface of Human biology and engineering	C2, C4	2	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 – Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Definition, goal & importance of physiology. Homeostasis: definition. Major functional systems, control systems of the body. Cellular Physiology and Blood. Composition and function of blood, Types of blood cell, Erythropoiesis, Anaemia, Phagocytosis, Hemostasis. Cardiovascular Physiology: Properties of cardiac muscle, Generation of cardiac impulse and its conduction in the heart, Cardiac cycle, heart sound, action potential of cardiac muscle, ECG. Gastrointestinal Physiology: Physiological anatomy of gastrointestinal (GI) tract. Local hormones of GIT: name, functions & regulation of secretion. Renal physiology: Kidney, functions of kidneys. Respiration: Mechanism, Pulmonary and Alveolar ventilation Pulmonary volumes and capacities and dead space, Respiratory unit and respiratory membrane, Diffusion of Gases through the respiratory membrane, Transport of Oxygen and Carbon dioxide in blood. Thermoregulation. Hormones: Definition, Classification, mechanism of action, regulation of secretion. Nervous system- Neuron- types, receptor and synapse, action potential of nerve fiber. Functional organization and functions of major levels of central nervous system

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the functions of the main organs of the body	3											
CO2	Be able to **understand** some basic pathologies and how they affect the function of the body	3											
CO3	Be able to **explain** and **analyze** the interface of Human biology and engineering		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	

Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Course introduction**	CT – 1 and Midterm, Final
Lecture 1	Motivation & introduction to Human Physiology	
Lecture 2	Organs of Physiological systems and functions	
Lecture 3	Engineering perspective to Human Physiology	
2	**Cells differentiation and Homeostasis**	
Lecture 4	Cell to cell interaction or Cell communication	
Lecture 5	Cell differentiation mechanisms	
Lecture 6	Feedback system in Homeostasis	
3	**Tissue**	
Lecture 7	Epithelial Tissue	
Lecture 8	Connective Tissue	
Lecture 9	Neural and Muscle tissue	
4	**Blood**	Midterm, Final
Lecture 10	Composition and function of blood	
Lecture 11	Types of blood cell, Erythropoiesis	
Lecture 12	Anaemia, Phagocytosis, Hemostasis	
5	**Cardiovascular Physiology**	
Lecture 13	Properties of cardiac muscle and role in blood flow	
Lecture 14	Generation of cardiac impulse and its conduction in the heart, Cardiac cycle, heart sound,	
Lecture 15	Action potential of cardiac muscle, ECG	
6	**Nervous System**	
Lecture 16	Classification of nervous system	
Lecture 17	Neurons and Glial cells, Synapses	
Lecture 18	Action potential of nerve fiber	
7	**Immune system**	
Lecture 19	Cellular and humoral response to infection	
Lecture 20	T helper cell differentiation, regulation and function	
Lecture 21	Crosstalk between Nervous system and Immune system	

MIDTERM		
8	**Muscular System**	CT – 2, FINAL
Lecture 22	Function and structure of muscle	
Lecture 23	Neuromuscular junction	
Lecture 24	Muscle contraction	
9	**Respiratory System**	
Lecture 25	Function and structure of Lungs	
Lecture 26	Systemic and pulmonary respiration	
Lecture 27	Respiratory regulation	
10	**Gastrointestinal Physiology**	
Lecture 28	Physiological anatomy of gastrointestinal (GI) tract	
Lecture 29	Local hormones of GIT	
Lecture 30	Regulation of secretion	
11	**Renal System**	
Lecture 31	Introduction and function of Kidney	
Lecture 32	Glomerular filtration rate (GFR)	
Lecture 33	Regulation on kidney function	
12	**Endocrine System**	CT – 3, FINAL
Lecture 34	Types of Glands	
Lecture 35	Types of Hormones	
Lecture 36	Mechanisms of hormone action	
13	**Hemodynamics and blood vessels**	
Lecture 37	Structure and functions of blood vessels	
Lecture 38	Mechanical properties of blood vessels	
Lecture 39	Engineering approach to blood pressure, flow and resistance.	
14	**Reproductive System, Ear and Eye**	
Lecture 40	Introduction to reproductive system	
Lecture 41	Hearing mechanism	
Lecture 42	Vision mechanism	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3	C2
	Class Participation	5%	CO3	C2
	Midterm	15%	CO1, CO2	C2
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Essentials of Anatomy and physiology, by Valerie C. Scanlon and Tina Sanders.
REFERENCE BOOKS
1. Seeley's Essentials of Anatomy and physiology, by CinnamoneVanputte, Jennifer Regan, Andrew Russo
REFERENCE SITE
-

6.1.5 BME 203 Biochemistry

COURSE INFORMATION			
Course Code Course Title	: BME 203 : Biochemistry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE
CHEM 103 – **General Chemistry**; CHEM 125 – Physical and Bio-organic Chemistry
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course aims to introduce students to structure and chemistry of different types of molecules and structures found in biological structures. Concepts in enzyme kinetics are covered in depth. Overview of molecules involved in genetics such as nucleic acid structures, and DNA and RNA replication steps are given. The metabolism and oxidation of polysaccharide, lipid, and protein are analyzed in detail. The generation and propagation of bioelectric potentials across membrane channels are also covered.
OBJECTIVE
1. To understand the basic concepts of enzyme kinetics 2. To describe the structure and mechanisms of nucleic acid, DNA, RNA, and genetic engineering 3. To explain and analyze the pathways of oxidation, energy transfer, and metabolism of energy sources and important biomolecules 4. To explain and characterize action potential generation and impulse propagation in membranes and nerve fibers
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** concepts of enzyme kinetics	C2	1	-	-	1	T, MID, F
CO2	Be able to **remember** the structure and chemistry of genetic material such as DNA	C1	1	-	-	1	MID, F
CO3	Be able to **understand** the processes involved in digestion and metabolism	C2	1	-	-	1	T, F
CO4	Be able to **understand** the concept of bioelectricity, membrane channels and the propagation of potentials	C2	1	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

ENZYMES KINETICS: Enzymes mechanism and activation energy; enzyme thermodynamics; kinetics and inhibition; Mikhaelis-Menten equation, inhibition, and regulation of enzyme activity
NUCLEIC ACID: nucleotides, Nucleotide Metabolism, DNA, RNA composition and simple structure; replication, transcription and translation, DNA repair and mutation, Recombination and Transposition, Genetic code and genetic engineering, RNA Synthesis and Regulation
VITAMINS AND COENZYMES.
Vitamins and coenzymes. Digestion of polysaccharides, lipids and proteins. Metabolism and energy transfer; Integration of Metabolism and Signal Transduction, glycolysis and oxidative phosphorylation; biological high-energy compounds. Oxidation of fatty acids and oxidative degradation of amino acids. Glucagenosis, Krebs Cycle, pyruvate dehydrogenase complex, cholesterol and steroid metabolism, Photosynthetic phosphorylation. Inter relationship and control metabolism. Some inborn errors of metabolism
BIOELECTRICITY: Introduction to Bioelectricity and Excitable Cells. Bioelectric potentials and currents: ionic composition of excitable cells, Nernst-Planck equation, membrane structure, Nernst potential, parallel-conductance model; membrane channels: channel structure, biophysical methods for measuring channel properties

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** concepts of enzyme kinetics	3											
CO2	Be able to **remember** the structure and chemistry of genetic material such as DNA	3											
CO3	Be able to **understand** the processes involved in digestion and metabolism	3											
CO4	Be able to **understand** the concept of bioelectricity, membrane channels and the propagation of potentials	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE		
Week	**Content**	**Assessment**
1	**Course introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Motivation & introduction to biochemistry	
Lecture 2	Introduction to enzymes kinetics	
Lecture 3	Enzymes mechanism and activation energy	
2	**Enzyme kinetics**	
Lecture 4	Enzyme thermodynamics	
Lecture 5	kinetics and inhibition	
Lecture 6	kinetics and inhibition	
3	**Enzyme kinetics continued**	
Lecture 7	Mikhaelis-Menten equation	
Lecture 8	inhibition of enzyme activity	
Lecture 9	regulation of enzyme activity	
4	**Nucleic acid**	
Lecture 10	Nucleotides, Nucleotide Metabolism	
Lecture 11	Composition of DNA and RNA, simple structure	
Lecture 12	Replication, transcription and translation	
5	**Nucleic acid continued**	**Midterm, Final**
Lecture 13	Replication, transcription and translation	
Lecture 14	DNA repair and mutation	
Lecture 15	DNA repair and mutation	
6	**Nucleic acid continued**	
Lecture 16	Recombination and Transposition	
Lecture 17	Genetic code and genetic engineering	
Lecture 18	RNA Synthesis and Regulation	
7	**Vitamins and coenzymes; Metabolism**	
Lecture 19	Introduction to vitamins and their types	
Lecture 20	Digestion of polysaccharides, lipids, and proteins	
Lecture 21	Metabolism and energy transfer	
MIDTERM		
8	**Digestion and metabolism**	**CT – 2, FINAL**
Lecture 22	Integration of Metabolism and Signal Transduction	
Lecture 23	Integration of Metabolism and Signal Transduction	
Lecture 24	Glycolysis and oxidative phosphorylation	
9	**Energy transfer and phosphorylation**	
Lecture 25	Glycolysis and oxidative phosphorylation	
Lecture 26	biological high-energy compounds	
Lecture 27	Oxidation of fatty acids and oxidative degradation of amino acids	
10	**Gluconeogenesis and Krebs cycle**	
Lecture 28	Gluconeogenesis	
Lecture 29	Gluconeogenesis	
Lecture 30	Krebs Cycle	
11	**Energy transfer and phosphorylation continued**	

Lecture 31	Pyruvate dehydrogenase complex	**CT – 3, FINAL**
Lecture 32	Cholesterol and steroid metabolism	
Lecture 33	Pentose phosphate pathway	
12	**Metabolism control**	
Lecture 34	Photosynthetic phosphorylation	
Lecture 35	Interrelationship and control metabolism	
Lecture 36	Some inborn errors of metabolism	
13	**Bioelectricity**	**FINAL**
Lecture 37	Introduction to Bioelectricity and Excitable Cells.	
Lecture 38	Bioelectric potentials and currents: ionic composition of excitable cells	
Lecture 39	Nernst-Planck equation, membrane structure, Nernst potential	
14	**Bioelectricity continued**	
Lecture 40	Parallel-conductance model	
Lecture 41	membrane channels: channel structure	
Lecture 42	biophysical methods for measuring channel properties	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2
	Class Participation	5%	CO2	C1
	Midterm	15%	CO1, CO2	C1, C2
Final Exam		60%	CO 1	C2
			CO 2	C1
			CO 3	C2
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Fundamentals of Enzyme Kinetics – 4th edition, Athel Cornish-Bowden.
2. Lehninger Principles of Biochemistry- 4th Edition, by Albert L. Lehninger, David L. Nelson, and Michael M. Cox.

REFERENCE BOOKS

1. Harper's Illustrated Biochemistry- 28th Edition by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil.
2. Bioimpedance and Bioelectricity Basics, S. Grimnes and O.G. Martinsen, Academic Press, 2000

REFERENCE SITE

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6.1.6 BME 204 Biochemistry Sessional

COURSE INFORMATION			
Course Code Course Title	: BME 204 : Biochemistry Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE
Course Code: BME 203 Course Title: Biochemistry
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course covers the application of biochemistry and associated laboratory techniques using experiments detecting biologically relevant substances such as glucose, cholesterol, and insulin.
OBJECTIVE
This course aims to enhance students' knowledge on the basic principles of biochemical reactions and their applications.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** the content of different biochemicals such as carbohydrates, proteins, and lipis.	C4	2, 5	-	-	1	T, Q, R
CO2	Be able to **analyze** the quantity of glucose, creatinine, cholesterol, insulin, and cortisol in blood.	C4	2, 5	-	-	1	T, Q, R
CO3	Be able to **apply** laboratory techniques such as centrifugation, chromatography, spectrophotometry, and immunoassay.	C3	2, 5	-	-	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Detection of carbohydrate in an unknown solution using Molisch's Test, Qualitative analysis of protein content using Biuret Test, Qualitative test for detecting the presence of lipids, Estimation of glucose content using colorimetric analysis, Preparation of serum and plasma from blood by centrifugation, Determination of blood glucose levels using enzymatic spectrophotometric analysis, Estimation of blood cholesterol content, Estimation of blood creatinine content, Separation of mixture components using high-performance liquid chromatography (HPLC), Measurement of insulin, Measurement of cortisol.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** the content of different biochemicals such as carbohydrates, proteins, and lipis.		3			3							
CO2	Be able to **analyze** the quantity of glucose, creatinine, cholesterol, insulin, and cortisol in blood.		3			3							
CO3	Be able to **apply** laboratory techniques such as centrifugation, chromatography, spectrophotometry, and immunoassay.		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to the course, laboratory rules, safety rules, and laboratory techniques. Introduction to ChemDraw	Report, Lab Test, Quiz, Viva
2	Use of colorimeter to estimate concentrations of colored compounds	
3	Detection of carbohydrate in an unknown solution using Molisch's Test	
4	Detection of reducing sugars using Benedict's Test	
5	Qualitative analysis of protein content using Biuret Test	
6	Qualitative analysis of protein content using Millon's Test	
7	Lab Quiz	
Midterm Break		
8	Determination of blood glucose levels using enzymatic spectrophotometric analysis	Report, Lab Test, Quiz, Viva
9	Preparation of serum and plasma from blood by centrifugation	
10	Preparation and visual examination of a blood smear	
11	Counting RBCs and WBCs using a hematocytometer	
12	Separation of chemical constituents from a sample using thin line chromatography	
13	Identification of chemical constituents using high performance liquid chromatography (HPLC)	
14	Final lab test + viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C3
	Quiz	30%	CO1, CO2, CO3	C4, C3
	Viva	10%	CO1, CO2, CO3	C4, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Lab Manual in Biochemistry, Immunology, and Biotechnology by Nigam, A &Ayyagari, A. 2008, McGraw Hill Education Publications
2. Biochemistry Laboratory: Modern Theory and Techniques (2nd Edition), by Boyer, RF. 2011, Prentice Hall Publications

REFERENCE SITE

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6.1.7 BME 205 Biofluid Mechanics and Heat Transfer

COURSE INFORMATION			
Course Code Course Title	: BME 205 : Biofluid Mechanics and Heat Transfer	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the topics/subtopics that include fluid continuum, forces acting on a fluid, Surface tension, Statics of fluids, manometers, fluids in motion, shear stress and classification of fluids, principles of continuity, conservations of mass, energy and momentum and their applications, laminar and turbulent flows and boundary layer, introduction to Navier Stoke equation, modes of heat transfer, heat transfer in living body, bioheat transfer modeling, temperature measuring devices.

OBJECTIVE

1. To understand basic laws of fluid mechanics.
2. To solve different fluid mechanics equations and apply them to real-world problems.
3. Apply principles of heat and mass transfer to basic engineering systems.
4. To analyze heat transfer by conduction, convection, and radiation.
5. To understand the working principle temperature measuring device.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **explain** different equations in biofluid mechanics.	C2	1	1	-	1, 3	T, F
CO2	Be able to **apply** different laws of fluid mechanics to physiological flow systems.	C3	2	1, 3	-	1, 3	T, F
CO3	Be able to **understand and explain** different heat transfer mechanisms.	C2	1	1	-	1	MID, F
CO4	Be able to **analyze** basic heat transfer problems, occur in Biomedical Engineering field involving Conduction, Convection and Radiation for providing appropriate solutions..	C4	2	1, 3	-	1, 3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Concept of fluid continuum, forces acting on a fluid, Surface tension, Statics of fluids: equation of static equilibrium, manometers, forces on submerged surfaces; Fluids in motion: concept of shear stress and classification of fluids; Fluid flow in closed conduits; laminar and turbulent flow; friction factor; control volume analysis: balance of mass, momentum and energy; continuity equation; momentum equation; Bernoulli's principle; Newton's law of viscosity, Navier-Stokes equations, Exact solutions of Navier-stokes equations, Couette flow, Poiseuille flow, the Rayleigh problem.

Basic modes of heat transfer; Introduction to Heat Transfer in Biological System, steady-state heat conduction through a layered surface with different thermophysical properties; Effect of metabolism on heat transfer, transient (unsteady-state) heat conduction; Heat transfer with phase change; Different approaches in bioheat transfer modeling; Thermal regulation of human body; Theoretical determination of thermal properties for biomaterial and experimental techniques; Temperature measuring devices.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** different equations in biofluid mechanics.	3											
CO2	Be able to **apply** different laws of fluid mechanics to physiological flow systems.		3										
CO3	Be able to **explain** heat and different heat transfer mechanisms.	3											
CO4	Be able to **evaluate** basic heat transfer problems occur in Biomedical Engineering field involving Conduction, Convection and Radiation for providing appropriate solutions.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method
COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to Fluid Mechanics**	**CT – 1, Final**
Lecture 1	Fluid as a continuum	
Lecture 2	Introduction to shear stress and shear strain	
Lecture 3	Mechanical properties in physiological flow conditions	
2	**Control Volume analysis**	
Lecture 4	Control Volume, velocity field and flow rates	
Lecture 5	Fluid acceleration and its derivation	
Lecture 6	Fluid Statics	
3	**Laws of conservation of Mass and Momentum**	
Lecture 7	Conservation laws in fluid flow	
Lecture 8	Boundary conditions in fully formed flows	
Lecture 9	Derivation of Buoyancy equations	
4	**Surface Tension**	**Midterm, Final**
Lecture 10	Surface tension in fluids	
Lecture 11	Surface tension in fluids	
Lecture 12	Surfactants and their roles in medicine and biology	
5	**Newton's laws of viscosity and the Reynolds Number**	
Lecture 13	Newton's laws of viscosity and different categories of fluid	
Lecture 14	Types of flows and Reynolds Number	
Lecture 15	Fluid flow in a rectangular cross-section	
6	**Fluid flow in different cross-sections**	
Lecture 16	Fluid flow in a rectangular cross-section	
Lecture 17	Fluid flow in a cylindrical cross-section	
Lecture 18	Fluid flow in a cylindrical cross-section	
7	**Principles in fluid mechanics**	
Lecture 19	Bernoulli's principles	
Lecture 20	Navier-Stokes equation	
Lecture 21	Review Class	
	Midterm Break	
8	**Modes of heat transfer**	**CT – 2, Final**
Lecture 22	Overview of heat, relation between thermodynamic and heat transfer	
Lecture 23	Conduction, Convection, and Radiation	
Lecture 24	Basic laws of heat conduction – Fourier's Law with derivation	
9	**Thermal properties**	
Lecture 25	Fourier's Law of conduction in different co-ordinate systems and bioheat transfer in mammalian	
Lecture 26	Boundary conditions in heat transfer problems	
Lecture 27	Steady state heat conduction through a slab, layered slab with different thermophysical properties (e.g. skin)	
10	**Conduction**	

Lecture 28	Steady state heat conduction through a slab, layered slab with different thermophysical properties (e.g. skin)	
Lecture 29	Thermal resistivity and modeling thermal resistance in different heat transfer problems	
Lecture 30	Steady state heat conduction through a cylinder and hollow cylinder	
11	**Conduction and Thermoregulation**	**CT – 3, FINAL**
Lecture 31	Effect of fur size in heat transfer with relation to mammal size The bio-heat transfer equation for mammalian tissue	
Lecture 32	Steady state heat conduction with internal heat generation	
Lecture 33	Principles of thermoregulation	
12	**Heat Transfer through extended surfaces**	
Lecture 34	Steady state heat transfer problem from extended surfaces: different boundary conditions	
Lecture 35	Steady state heat transfer from extended surfaces: examples mathematical and real-life	
Lecture 36	The bioheat equation and multimodal heat transfer problem	
13	**Convection**	**FINAL**
Lecture 37	The bioheat equation and multimodal heat transfer problem	
Lecture 38	Convection and thermal/velocity boundary layer	
Lecture 39	Local and average convection co-efficient	
14	**Heat Transfer in phase change**	
Lecture 40	Heat transfer with phase change	
Lecture 41	Freezing of pure water, solution, cells and tissues and thawing	
Lecture 42	Review Class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)
TEXT BOOKS
Biofluid Mechanics: 1. Applied Biofluid Mechanics, Lee Waite and Jerry Fine. ISBN -10: 0-07-147217-7 **Heat Transfer:** 1. Ashim K. Datta, Biological and Bioenvironmental Heat and Mass Transfer: Marcel Dekker, Inc., 2002.
REFERENCE BOOKS
Biofluid Mechanics: 1. A Brief Introduction to Fluid Mechanics, Young, Munson, and Okiishi; Fifth Edition **Heat Transfer:** 1. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer: John Wiley & Sons; 5th edition 2006.
REFERENCE SITE
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6.1.8 BME 206 Biofluid Mechanics and Heat Transfer Sessional

COURSE INFORMATION			
Course Code Course Title	: BME 206 : Biofluid Mechanics and Heat Transfer Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE
Course Code: BME 205 Course Title: Biofluid Mechanics and Heat Transfer
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course covers the application of fluid mechanics and heat transfer in the biological context using experimental and computational knowledge.
OBJECTIVE
This course aims to enhance students' knowledge on the basic principles of fluid mechanics and heat transfer solutions.
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** the different hemodynamic and fluid flow scenarios for accessing the physiological condition of human body.	C4	2		1	1	T, Q, R
CO2	Be able to **analyze** different fluid flow behavior in human body using software to **evaluate** and predict pathophysiological conditions.	C4, C5	5		1, 3	1, 2	T, Q, R, ASG

CO3	Be able to **apply** the concept of heat transfer for assessing burn injury.	C3	2		1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Bernoulli’s theorem with a venturi tube, Friction loss in biological systems, Biomedical circulatory system in normal and pathological conditions, Rheological behavior of biological fluid analogs, Study of dialysis machine, Spirometric measurements of lung function test by determination of FVC, FEVs and MVV using the concept of volumetric flow rate, Analysis of intravascular and near-wall hemodynamics, Study of frictional flow, Burnt injury in blood-perfused skin, Vessel segmentation from CT image, Intra aneurysmal flow simulation.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** the different hemodynamic and fluid flow scenarios for accessing the physiological condition of human body.		3										
CO2	Be able to **analyze** different fluid flow behavior in human body to **evaluate** and predict pathophysiological condition.					3							
CO3	Be able to **apply** the concept of heat transfer for assessing burn injury.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25

Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to fluid dynamics and associated software for fluid dynamics modeling	Report, Assignment, Lab Test, Quiz, Viva
2	Analysis of stented artery based on the intra aneurysmal flow simulation	
3	Analysis of intravascular and near-wall hemodynamic of bifurcation artery: An idealized and patient-specific study	
4	Segmentation of vessel with aneurysm from CT image using Materialize MIMICS and 3MATIC	
5	Study of Bernoulli's theorem with a venturi meter	
6	Study of biomedical circulatory system in normal and pathological conditions	
7	Lab Test 1	
	Midterm Break	
8	Fluid flow analysis of a dialysis machine	Report, Lab Test, Quiz, Viva
9	Spirometry measurement of lung function test by determination of FVC, FEVs and MVV using the concept of volumetric flow rate	
10	Rheological behavior of biological fluid analogs	
11	Burnt injury in blood-perfused skin	
12	Review class/Practice session	
13	Lab Test 2	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

Biofluid Mechanics:

1. Applied Biofluid Mechanics, Lee Waite and Jerry Fine. ISBN -10: 0-07-147217-7

Heat Transfer:

1. Ashim K. Datta, Biological and Bioenvironmental Heat and Mass Transfer: Marcel Dekker, Inc., 2002.

REFERENCE BOOKS
Biofluid Mechanics:
1. A Brief Introduction to Fluid Mechanics, Young, Munson, and Okiishi; Fifth Edition
Heat Transfer:
1. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer: John Wiley & Sons; 5th edition 2006.
REFERENCE SITE
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6.1.9 BME 207 Biomedical Instrumentation and Measurements

COURSE INFORMATION			
Course Code Course Title	: BME 207 : Biomedical Instrumentation and Measurements	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

EECE 191: Principles of Electrical Engineering, EECE 291: Electronic Circuits and Devices, BME 201: Human Physiology

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course is designed to give the basic concepts of Instrumentation involved in medical field and human physiology. In the course, students will be introduced to fundamentals of transducers and sensors, bio-signal measurements and concepts of the instrumentation related to biosignal measurements. The course covers the following modules: generalized medical instrumentation, transducers and sensors, bio amplifier, bio-signal recording systems, bio-signals and their measurement techniques, instrumentation of bio-signal measurements, and patient safety.

OBJECTIVE

1. To understand the basics of biomedical instrumentation.
2. To learn the principles of transducers and sensors.
3. To understand and apply various biomedical measurement techniques.
4. To analyze and design various biomedical instrumentation techniques.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basics of Biomedical instrumentation and measurements.	C2	1	1	-	1	T, F
CO2	Be able to **understand** the principles of transducers and sensors.	C2	1	1	-	1	T, F
CO3	Be able to **apply** various biomedical instrumentation to **analyze** and solve biomedical problems.	C3, C4	2, 5	1	-	1, 3	MID, F
CO4	Be able to **apply** various biomedical measurement techniques.	C3	5	1, 3	-	1, 3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Fundamentals of Medical Instrumentation: Generalized Medical Instrumentation System, Classification of Biomedical Instruments, Performance requirements of Medical Instrumentation System, General static characteristics: precision, resolution, accuracy, uncertainty, sensitivity, repeatability, calibration, maintenance, reparability, etc., General dynamic characteristics; Design process of medical instruments, Commercial medical instrumentation development process; General Constraints in Design of Medical Instrumentation Systems, regulation of medical devices.

Principles of Transducers and Sensors: The principle, classification, characteristics of Transducers and sensors, Displacement, Position, Motion, Thermal, Pressure, Force, Photoelectric, Optical, Radiative, Ultrasonic, Electrochemical sensors, Biosensors

Biopotential and Electrodes: Laws of membrane biophysics: electrical properties of cells and electrical equivalent model for the cell membrane; action potential. Origin of Bioelectric Signals (ECG, EEG, EMG, EOG, ENG, MEG, etc.) and their properties; Biopotential Electrode: Principle, Construction, Circuit model, types, Electrode-Skin interface, Polarization , artefacts and reduction technique, Electrodes for bioelectric signals, Electrode Arrays, Microelectrodes

Recording Systems, Amplifiers and Signal Conditioning: Basic Recording Systems, General Considerations for Signal Conditioners, Preamplifiers: Differential Amplifier, Instrumentation Amplifier, Carrier Amplifiers, Chopper Amplifier, Isolation amplifier, Power Amplifier, Filters for biomedical applications, Constant Current Source, Current to Voltage Converter, Analog and Digital Recorders

Instrumentation and Measurements of Biomedical Parameters: Basic Instrumentation and Measurement of ECG, EEG, EMG, EOG, PPG and other biomedical recorders. Measurement of Heart Rate, Heart Rate Variability and Pulse rate, Measurement of Body Temperature, Measurements of Blood Pressure, sound, flow, and Volume, Measurements of the Respiratory System: Pressure, Gas-flow, Lung Volume, Gas Concentration, Measurement of Nerve conduction Velocity, Measurement of Bio-impedance, Electrical Impedance Tomography (EIT).

Patient Safety: Physiological Effects of Electricity, Important Susceptibility Parameters, Electric Shock Hazards: Macro and Micro, Basic Approaches to protection against shock, Isolation circuits and Isolation mechanism, Protection: Power Distribution and Equipment Design, Safety codes and Standards for Electromedical Equipment

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basics of Biomedical instrumentation.	3											
CO2	Be able to **understand** the principles of transducers and sensors.	3											
CO3	Be able to **apply** various biomedical instrumentation to **analyze** and solve biomedical problems.		3			3							
CO4	Be able to **apply** various biomedical measurement techniques.					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Fundamentals of Medical Instrumentation**	**CT – 1, Final**
Lecture 1	Introduction to Biomedical Instrumentation	
Lecture 2	Generalized Medical Instrumentation System. Classification of Biomedical Instruments	
Lecture 3	General static characteristics: precision, resolution, accuracy, uncertainty, sensitivity, repeatability, calibration, maintenance, reparability, etc.	
2	**Fundamentals of Medical Instrumentation**	
Lecture 4	Generalized Dynamic Characteristics	
Lecture 5	Generalized Dynamic Characteristics	
Lecture 6	Design process of medical instruments, Commercial medical instrumentation development process, Performance requirements of Medical Instrumentation System.	
3	**Principles of Transducers and Sensors**	
Lecture 7	The principle, classification, characteristics of Transducers and sensors	
Lecture 8	Displacement, Position, Motion Transducer	
Lecture 9	Thermal, Pressure, Force Transducer	
4	**Physiological Transducers and Sensors**	**Midterm, Final**
Lecture 10	Photoelectric, Optical, Radiative Transducer	
Lecture 11	Ultrasonic, Electrochemical Transducer	
Lecture 12	Various Biosensors	
5	**Bioelectric Signals and Electrodes**	
Lecture 13	Biopotential, Laws of membrane biophysics: electrical properties of cells and electrical equivalent model for the cell membrane	
Lecture 14	Origin of Bioelectric Signals (ECG, EEG, EMG, EOG, ENG, MEG) and their properties	
Lecture 15		

6	**Bioelectric Signals and Electrodes**	
Lecture 16	Bio-potential Electrode: Principle, Construction, Circuit model, types	
Lecture 17	Electrode-Skin interface, Polarizations, Artefacts and Interference	
Lecture 18	Electrodes for bioelectric signals. Electrode Arrays, Microelectrodes	
7	**Recording Systems, Amplifiers and Signal Conditioning**	
Lecture 19	Basic Recording Systems, General Considerations for Signal Conditioners	
Lecture 20	Preamplifiers: Differential Amplifier, Instrumentation Amplifier	
Lecture 21	Carrier Amplifiers, Isolation amplifier, Driving Amplifier	
	Midterm Break	
8	**Recording Systems, Amplifiers and Signal Conditioning**	**CT – 2, Final**
Lecture 22	Sources of noise in low-level measurements and reduction techniques	
Lecture 23	Filters for biomedical applications and Frequency Response	
Lecture 24	Analog and Digital Recorders	
9	**Instrumentation and Measurements of Biomedical Parameters**	
Lecture 25	Basic Instrumentation and Measurement of ECG	
Lecture 26	Basic Instrumentation and Measurement of ECG	
Lecture 27	Basic Instrumentation and Measurement of PPG, Heart Rate, Heart Rate Variability.	
10	**Instrumentation and Measurements of Biomedical Parameters**	
Lecture 28	Basic Instrumentation and Measurement of EMG	
Lecture 29	Measurement of Nerve conduction Velocity.	
Lecture 30	Basic Instrumentation and Measurement EEG.	
11	**Instrumentation and Measurements of Biomedical Parameters**	**CT – 3, FINAL**
Lecture 31	Measurement of EOG and Other Biomedical Recorders	
Lecture 32	Measurements of Blood Pressure, sound, flow, and Volume.	
Lecture 33		
12	**Instrumentation and Measurements of Biomedical Parameters**	
Lecture 34	Measurements of the Respiratory System: Pressure, Gas-flow, Lung Volume, Gas Concentration	
Lecture 35		
Lecture 36		
13	**Instrumentation and Measurements of Biomedical Parameters**	**FINAL**
Lecture 37	Constant Current Source, Current to Converter	
Lecture 38	Measurement of Bioimpedance	
Lecture 39	Electrical Impedance Tomography (EIT)	
14	**Electrical Safety**	
Lecture 40	Physiological Effects of Electricity,	

	Important Susceptibility Parameters, Electric Shock Hazards: Macro and Micro	
Lecture 41	Basic Approaches to protection against shock, Isolation circuits and Isolation mechanism	
Lecture 42	Protection: Power Distribution and Equipment Design, Safety codes and Standards for Electromedical Equipment	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C4
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor domain, A= Affective Domain)

TEXT BOOKS

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.

REFERENCE BOOKS

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 1st edition, Pearson Education, New Delhi, 2007

REFERENCE SITE

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6.1.10 BME 208 Biomedical Instrumentation and Measurements Sessional

COURSE INFORMATION

Course Code Course Title	: BME 208 : Biomedical Instrumentation and Measurements Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 207

Course Title: Biomedical Instrumentation and Measurements

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of Biomedical Instrumentation and Measurements using experimental and computational knowledge.

OBJECTIVE

This course aims to enhance students' knowledge on the basic principles of Biomedical Sensor, Biomedical Instrumentation, and measurements, and develop biomedical instruments.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the principles of transducers and sensors.	C2	2	1	-	1	T, Q, R
CO2	Be able to **apply** various biomedical instrumentation to analyze and solve biomedical problems.	C3	2, 5	1, 3	-	1, 2	T, Q, R
CO3	Be able to **apply** various biomedical measurement techniques.	C4	5	1	-	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Biomedical Instrumentation and Measurements, Intro to basic sensors, Basic amplifiers (Inverting and Non-Inverting), Differential Amplifier, Instrumentation Amplifier, Biomedical Filters and frequency response analysis, constant current source and current to voltage converter, Bio-impedance measurement, Isolation Circuitry and Patient Safety protocols, ECG Data acquisition, EMG Data acquisition, PPG Data acquisition circuit and measurement of heart rate. Measurement of Nerve conduction velocity

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the principles of transducers and sensors.		3										
CO2	Be able to **apply** various biomedical instrumentation to **analyze** and solve biomedical problems.		3			3							
CO3	Be able to **apply** various biomedical measurement techniques.					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to Biomedical Instrumentation and Measurements sessional and Intro to basic sensors	Report, Assignment, Lab Test, Quiz, Viva
2	Implementation of amplifiers (Inverting and Non-Inverting), Differential Amplifier	
3	Implementation of Instrumentation Amplifier	
4	Implementation of Biomedical Filters and frequency response analysis	
5	Implementation of constant current source and current to voltage converter	
6	Design and Implementation of Bioimpedance measurement circuit.	
7	Implementation of Isolation Circuitry and Patient Safety protocols	
	Midterm Break	
8	Design and Implementation of an ECG Data acquisition circuit.	Report, Lab Test, Quiz, Viva
9	Design and Implementation of an EMG Data acquisition circuit	
10	Design and Implementation of a PPG Data acquisition circuit and measurement of heart rate.	
11	Measurement of Nerve conduction velocity	
12	Review class	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C3, C2
	Class Participation	20%	CO1, CO2, CO3	C4, C3, C2
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C3, C2
	Quiz	30%	CO1, CO2, CO3	C4, C3, C2
	Viva	10%	CO1, CO2, CO3	C4, C3, C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.

REFERENCE BOOKS

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 1st edition, Pearson Education, New Delhi, 2007

REFERENCE SITE

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6.1.11 BME 301 Statistics and Numerical Methods for Biomedical Engineers

COURSE INFORMATION

Course Code Course Title	: BME 301 : Statistics and Numerical Methods for Biomedical Engineers	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: MATH 205
Course Title: Differential Equation, Laplace Transform and Fourier Transform

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To teach the students the basic concepts and principles of numerical methods and statistics. It is targeted to provide a basic foundation for mathematics areas such as various numerical approximations of linear equations and DEs etc. Finally, this course is designed to develop the capability of solving real- life problems through Numerical methods and giving statistical interpretation and comments.

OBJECTIVE

1. Be able to understand the basic knowledge of various numerical approximations for solving equations.
2. Be able to provide a statistical probability of any real-life problem.
3. Implement numerical methods and statistical concepts in solving different engineering problems.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** different numerical methods.	C2	1	1		1	T, F, ASG
CO2	Be able to **identify** and **analyze** statistical data and probability concepts.	C2	2	1		1,2	T, MT, F, ASG
CO3	Be able to **apply** numerical methods, sampling theory and different statistical tests to solve real-world problems.	C3	5	1		1,2	MT, F
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; MT– Midterm Exam; ASG – Assignment; F – Final Exam)						

COURSE CONTENT

Numerical Methods For Biomedical Engineering:

Numerical Solution of Algebraic and Transcendental Equations: Introduction, Bisection method, Newton-Raphson method. Solution of system of linear equations using direct and iterative method.

Interpolation: Finite differences, Forward and backward differences, Difference table, difference of polynomial. Newton forward and backward interpolation formula, Central and divided differences, Numerical Integration Numerical solution of ordinary differential equations.

Statistics:

Correlation: Scatter diagrams, Correlation co-efficient, Rank correlation, Correlation ratio, Theorems on correlations.

Regression Analysis: Linear regression, Equation of the line of regression, Regression co-efficient, Curve fitting, Method of least square.

Probability: Mathematical and statistical definitions, Additive and multiplicative rule of probability, Conditional probability, Baye's theorem, joint probability.

Random Variables: Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution functions, Mathematical expectation.

Discrete Probability Distribution: Binomial distribution, Negative binomial distribution, Geometric distribution, Poisson's distribution.

Continuous Probability Distribution: Normal distribution, Exponential distribution, Chi-square distribution, t and F- distributions.

Sampling Distribution: Population, Sample mean, Sample variance, Central limit theorem, Sampling distribution from a normal population.

Test of Hypothesis: Statistical hypothesis, Level of significance, Type I and Type II error, One tailed and two tailed tests, Tests for proportions.

Analysis of Variance: One way and Two classification of ANOVA

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** different numerical methods.	3											
CO2	Be able to **identify** and **describe** statistical data and probability concepts.		3										
CO3	Be able to **Apply** numerical methods, sampling theory and different statistical tests to solve real-world problems.					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1(a)	**3**	The knowledge of mathematics has to be applied to understand different numerical methods in the field of engineering study.
CO2-PO1(a)	**3**	In order to identify and describe statistical phenomena and probability distribution, using the knowledge of mathematics and sciences is required.
CO3-PO1(a)	**3**	Interpret various numerical methods and statistical phenomena to solve DEs using them, the knowledge of mathematics is required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1	Numerical Analysis	
Class 1	**Numerical Solution of Algebraic and Transcendental Equations**: Introduction	CT 1
Class 2	Bisection method	
Class 3	Newton-Raphson method	
Week 2	**Numerical Analysis**	
Class 4	Solution of system of linear equations using direct method	
Class 5	Solution of system of linear equations using iterative method	
Class 6	**Interpolation**: Finite differences, Forward differences	
Week 3	**Numerical Analysis**	
Class 7	**Interpolation**: Finite differences, backward differences	
Class 8	Central differences, Divided differences, Difference table	
Class 9	Central differences, Divided differences, Difference table	
Week 4	**Numerical Analysis**	CT 2
Class 10	difference of polynomial	
Class 11	Newton interpolation formula	
Class 12	Newton forward interpolation formula, Newton backward interpolation formula	
Week 5	**Numerical Analysis**	
Class 13	Numerical Integration	
Class 14	Numerical solution of ordinary differential equations	
Class 15	Application of numerical methods in Biomedical Engineering	
Week 6	**Statistics**	
Class 16	Introduction to statistics, correlation: Scatter diagrams, Correlation co-efficient	
Class 17	Rank correlation, Correlation ratio, Theorems on correlations.	
Class 18	**Regression Analysis**: Linear regression	
Week 7	**Statistics**	Mid Term
Class 19	Least square method Equation of the line of regression	
Class 20	Regression co-efficient, Curve fitting	
Class 21	**Probability:** Mathematical and statistical definitions, Additive and multiplicative rule of probability	
Week 8	**Statistics**	
Class 22	Conditional probability, Joint Probability, Baye's theorem	
Class 23	Conditional probability, Joint Probability, Baye's theorem	
Class 24	**Random Variables:** Discrete and continuous random variables,	
Week 9	**Statistics**	
Class 25	Random Variable: Probability mass function	
Class 26	Probability density function, Cumulative distribution functions	
Class 27	Mathematical expectation.	
Week 10	**Statistics**	
Class 28	**Discrete Probability Distribution:** Binomial distribution,	
Class 29	Negative binomial distribution, Geometric distribution	
Class 30	Poisson's distribution.	
Week 11	**Statistics**	

Class 31	**Continuous Probability Distribution**: Normal distribution: Introduction	**CT 3**
Class 32	**Continuous Probability Distribution**: Normal distribution: Theory	
Class 33	**Continuous Probability Distribution**: Normal distribution: Example	
Week 12	**Statistics**	
Class 34	Exponential distribution, Chi-square distribution, t and F- distributions	
Class 35	**Sampling Distribution**: Population, Sample mean, Sample variance	
Class 36	Central limit theorem, Sampling distribution from a normal population.	
Week 13	**Statistics**	
Class 37	**Test of Hypothesis**: Statistical hypothesis, Level of significance, Type I and Type II error	
Class 38	One tailed and two tailed tests, Tests for proportions.	
Class 39	Effect size Cohen's D method	
Week 14	**Statistics**	
Class 40	Analysis of Variance (ANOVA): One tailed and Two tailed tests	
Class 41	Analysis of Variance: Example	
Class 42	Statistical applications in Biomedical Engineering	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C2
			CO3	C3
	Class Participation	5%	CO1, CO2, CO3	C2, C3
	Midterm	15%	CO 2, CO3	C2, C3
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Numerical analysis, Walter Gautschi
2. Probability and Statistics for Engineers, Scheaffer & McClave.

REFERENCE BOOKS

1. Introduction to Statistics for Biomedical Engineers, Kristina M. Ropella
2. Business Statistics, Gupta and Gupta.

REFERENCE SITE

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6.1.12 BME 302 Statistics and Numerical Methods for Biomedical Engineers Sessional

COURSE INFORMATION			
Course Code Course Title	: BME 302 : Statistics and Numerical Methods for Biomedical Engineers Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE
Course Code: BME 301 Course Title: Statistics and Numerical Methods for Biomedical Engineers
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
A biomedical engineer or researcher has to deal with different form of complex computational problems in his/her academic and professional life. Besides, from a large scale computation and analysis different forms of statistical decisions are to make by the biomedical engineers and researchers. To make these sorts of numerical and statistical computations simpler, faster, more efficient and accurate, learning about well-known statistical and numerical methods are obligatory. This laboratory coursework includes some of these statistical and numerical techniques like regression, curve fitting, interpolation, root finding, numerical calculus, solving linear and non-linear equations, higher order statistical measures, different statistical distributions, hypothetical tests, etc. This course covers the application of the statistical and numerical methods to solve the real-life problems using computer programming language like MATLAB, Python, R, etc.
OBJECTIVE
To develop students' skill of applying different statistical and numerical methods to solve real-life biomedical engineering problems utilizing the analytical tools like MATLAB, Python, R, etc.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** and **apply** different statistical techniques to solve the related problems.	C3, C4	2, 5	-	-	1	T, Q, R
CO2	Be able to **analyze** and **apply** different numerical methods to solve real-life mathematical problems.	C3, C4	2, 5	-	-	1	T, Q, R
CO3	Be able to **compare** between different statistical and numerical techniques to conclude about the suitable technique for efficient and accurate results.	C5	2, 5	-	-	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to MATLAB/Python/R; Curve fitting problems and solutions using Linear Regression, Polynomial Regression, and Lagrange's Interpolation formula; Numerical root finding approach using Bisection Method, False Position Method, and Newton-Raphson Method; Numerical differentiation; Numerical integration; Finding the solutions of a linear system; Finding the concept of lower and higher order moments of random variables; Familiarization to the Probability, Conditional Probability, and Joint Probability, and the implementation techniques of Histogram, PDF's, CDF's of random variables, Binomial Distribution, Negative Binomial Distribution, Geometric Distribution, Normal Distribution and Poisson's distribution; Overview on the Statistical Hypothesis Test and execution of z-test, t-test, and Chi-Square ($\chi 2$) test for the statistically hypothetical decision making on Biomedical data; One-way and Two-way Analysis of Variances (ANOVA) for the statistical significance test of Biomedical data.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** and **apply** different statistical techniques to solve the related problems.		3			3							
CO2	Be able to **analyze** and **apply** different numerical methods to solve real-life mathematical problems.		3			3							
CO3	Be able to **compare** between different statistical and numerical techniques to conclude about the suitable technique for efficient and accurate results.		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75

Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to Statistics and Numerical Analysis Tools (MATLAB/Python/R)	Report, Lab Test, Quiz, Viva
2	Introduction to curve fitting problems related to Biomedical Engineering and their solutions using Linear Regression, Polynomial Regression, and Lagrange's Interpolation formula.	
3	Numerical approach to find the root of a non-linear equation using Bisection Method, False Position Method, and Newton-Raphson Method.	
4	Numerical differentiation using Forward Difference and Backward Difference approaches.	
5	Numerical integration using Trapezoidal, Simpson's (1/3), and Simpson's (3/8) rules.	
6	Finding the solutions of a linear system (a set of equations with multiple variables) using Gauss-Jordan Elimination through Pivoting and Gauss-Siedel Iterative methods.	
7	Lab Quiz	
Midterm Break		
8	Introduction to the random variables in biomedical engineering problems and the concept of method of moments to find lower and higher order moments of random variables.	Report, Lab Test, Quiz, Viva
9	Familiarization to the Probability, Conditional Probability, and Joint Probability, and the implementation techniques of Histogram, PDF's, CDF's of random variables.	
10	Familiarization and Implementation of Binomial Distribution, Negative Binomial Distribution, Geometric Distribution, Normal Distribution and Poisson's distribution.	
11	Overview on the Statistical Hypothesis Test and execution of z-test, *t*-test, and Chi-Square (χ^2) test for the statistically hypothetical decision making on Biomedical data.	
12	A gentle introduction to the execution of One-way and Two-way Analysis of Variances (ANOVA) for the statistical significance test of Biomedical data.	
13	Final lab test	
14	Final Quiz + Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C3
	Quiz	30%	CO1, CO2, CO3	C4, C3
	Viva	10%	CO1, CO2, CO3	C4, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

3. Numerical Methods for Engineers by Steven C. Chapra & Raymond P. Canale. 2015 (Seventh Edition), McGraw Hill Education Publications
4. Statistics in MATLAB: A Primer By MoonJung Cho, Wendy L. Martinez. 2015 (First Edition), CRC Press.
5. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB (Cambridge Texts in Biomedical Engineering) 1st Edition; by Michael R. King and Nipa A. Mody.

REFERENCE SITE

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6.1.13 BME 303 Biomechanics

COURSE INFORMATION

Course Code Course Title	: BME 303 : Biomechanics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

ME 291: Principle of mechanical engineering
PHY 127: Structure of matter, Electricity, Magnetism, and Mechanics

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the major topics/subtopics that include introduction to biomechanics, tissue mechanics, joint biomechanics, movement mechanics, dynamics to human motion, linear and angular kinematics, examples in biomechanics, modern kinematic measurement techniques, applications of human motion analysis, introduction to viscoelasticity.

OBJECTIVE

1. To describe the fundamental of biomechanics.
2. To Study the deformability, strength, viscoelasticity of bone and flexible tissues, modes of loading and failure.
3. To describe the types and mechanics of skeletal joints.
4. To describe movement precisely, using well defined terms (kinematics) and also to consider the role of force in movement (kinetics).
5. To teach students the unique features of biological flows, especially constitutive laws and boundaries.

6. To consider the mechanics of orthopedic implants and joint replacement, artificial heart valve, mechanical properties of cardiovascular and respiratory mechanics

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **explain** the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.	C2	1	1	-	1	T, F
CO2	Be able to **understand** various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior	C4	2	1	-	1, 3	T, F
CO3	Be able to **analyze** the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.	C2	1	1	-	1, 3	MID, F
CO4	Be able to **understand** mechanics at the cellular and tissue levels and explain the role of mechanobiology in different diseases	C5	4	1	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Kinematic and Kinetic Concepts:
Forms of motion, Standard reference terminology, Joint movement terminology, Force, moment, couples, loads on the human body, Equations of static equilibrium, Structural idealization applications in biomechanics, stress and strain analysis.

Muscle and Movement:
Skeletal muscle morphology, Isotonic versus isometric construction, Muscles constitutive modelling, whole muscle mechanics parallel versus pinnate muscle types, Factors affecting muscular force generation; Muscular strength, power, endurance; muscle and bone interactions.

Basic Statics and Movements at Specific Joints:
Shoulder and Shoulder Girdle; Elbow and Forearm; Wrist and Hand; Trunk and Spine; Hip, Knee, Ankle; Patterns of movement; Structural and Functional Analysis.

Linear and Angular Kinematics of Human Movement:
Overview of linear kinematics, Acceleration, Projectile motion analysis, Linear and angular motion relationship, Modern kinematics measurement techniques.

Linear and Angular Kinetics of Human Movement:
Kinetic law of motion, Angular analogues of Newton's law of motion, Modern kinetics measurement techniques, Application of human motion.

Human Movement in Fluid Medium:
Nature of fluid, Viscoelasticity, Buoyancy, Drag, Lift force, Propulsion in fluid medium.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **explain** the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.	3											
CO2	Be able to **understand** various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior	3											
CO3	Be able to **analyze** the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.		3										
CO4	Be able to **understand** mechanics at the cellular and tissue levels and explain the role of mechanobiology in different diseases	3											

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Kinematic and Kinetic Concepts**	CT – 1, Final
Lecture 1	Forces, moments, couples, mechanical loads and effects of loading	
Lecture 2	Forms of motion, Anatomical reference position, planes and axes, Joint movement terminology	
Lecture 3	Equations of static equilibrium and structural idealization applications in biomechanics	
2	**Human Motion Analysis**	
Lecture 4	Modern kinematic measurement techniques	
Lecture 5	Applications of human motion analysis	
Lecture 6	The human gait cycle	
3	**Linear kinematics**	
Lecture 7	Rigid body mechanics	
Lecture 8	Linear kinematics in human motion: measurements and analysis	
Lecture 9	Joint kinematics and Euler's angles	
4	**Angular Kinematics**	Midterm, Final
Lecture 10	Angular kinematics relationships, comparison between angular and linear kinematics	
Lecture 11	Angular kinematics of different joints	
Lecture 12	Kinetics in human motion – center of pressure, and ground reaction forces	
5	**Kinetics in human motion**	
Lecture 13	Analysis of ground reaction forces in different axis	
Lecture 14	Forces and moments determination in kinetic studies	
Lecture 15	Determination of joint moments and power	
6	**Musculoskeletal System**	
Lecture 16	Review: stress-strain analysis of materials	
Lecture 17	Introduction to musculoskeletal system- bone anatomy and architecture	
Lecture 18	Mechanical properties of bone, fracture mechanics and healing	
7	**Muscles and Movement**	
Lecture 19	Skeletal muscle morphology and architecture	
Lecture 20	Isotonic versus isometric contraction	
Lecture 21	Muscles constitutive modelling, Whole muscle mechanics parallel versus pinnate muscle types	
Midterm Break		
8	**Introduction to Joints**	CT – 2, Final
Lecture 22	Joint – structure and properties	
Lecture 23	Joint – types and movement	
Lecture 24	Structure, movement and loads on the shoulder	
9	**Human Joint Articulation**	
Lecture 25	Joint Architecture, stability and flexibility	
Lecture 26	Common Joint injuries and introduction to the biomechanics of human upper extremity	

Lecture 27	Structure, movement and loads on the shoulder	
10	**Joint Movement Analysis**	
Lecture 28	Structure, movement and loads on the elbow and wrist	
Lecture 29	Structure, movement and loads on the hip, knee and ankle	
Lecture 30	Problem solving	
11	**Joint Movement Analysis of Spine**	**CT – 3, FINAL**
Lecture 31	Stress relaxation properties of articular cartilage	
Lecture 32	Structure, properties and functions of spine	
Lecture 33	Spine mechanics and movement	
12	**Mechanics of tendons, ligaments and articular cartilage**	
Lecture 34	Structure and organization of tendons and ligaments	
Lecture 35	Mechanical and viscoelastic properties of tendons and ligaments	
Lecture 36	Structure, function and mechanical properties of articular cartilage	
13	**Introduction to cell mechanics and mechanobiology**	**FINAL**
Lecture 37	Overview of multi-scale mechanobiology	
Lecture 38	Cell/tissue mechanics – implications in development and disease	
Lecture 39	Cell/tissue mechanics – implications in development and disease	
14	**Review Class**	
Lecture 40	Single cell and bulk tissue mechanical measurements systems	
Lecture 41	Review and Mathematical problem solving	
Lecture 42		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3	C2, C4, C5
	Class Participation	5%	CO3	C2
	Midterm	15%	CO3	C2
Final Exam		60%	CO 1	C2
			CO 2	C4
			CO 3	C2
			CO 4	C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Susan J. Hall, Basic Biomechanics, McGraw Hill, Sixth Edition.
2. Emico okuno, Luciano Fratin, Biomechanics of the Human Body, Springer.

REFERENCE SITE

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6.1.14 BME 304 Biomechanics Sessional

COURSE INFORMATION			
Course Code Course Title	: BME 304 : Biomechanics Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 303

Course Title: Biomechanics

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of experimental analysis and computational techniques to the biomechanics of the human body.

OBJECTIVE

This course aims to introduce students to the generation and analysis of biomechanical models and data.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** the electromyography signal and mechanics of muscle contraction and joints.	C4	2, 5	-	1	1	T, Q, R
CO2	Be able to **analyze** the linear and angular kinetics and kinematics of a body in motion.	C4	2, 5	-	1	1	T, Q, R
CO3	Be able to **evaluate** the computational model of a body in motion.	C5	2, 5	-	1,3	2	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Introduction to skeletal biomechanics, The study of muscular contraction using electromyography, The study of joint biomechanics, Linear Kinematics of an object in motion and total body center of mass determination, Introduction to linear kinetics and analysis of vertical ground reaction force, Introduction to angular kinematics and range of motion, Creating and simulating the computational model of a dynamic body in motion, Biomedical Orthosis/ Prosthesis design & simulation, Study of Ankle Injury Using OpenSim (Both Free Fall & AFO Assisted), Creating and simulating the computational model of a static and dynamic body in motion

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** the electromyography signal and mechanics of muscle contraction and joints.		3			3							
CO2	Be able to **analyze** the linear and angular kinetics and kinematics of a body in motion through experimental and computational models		3			3							
CO3	Be able to **evaluate** orthosis/prosthetics through computational solid dynamics		3			3							
CO4	Be able to **evaluate** the computational model of a body in motion		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to skeletal biomechanics	Report, Lab Test, Quiz, Viva
2	The study of muscular contraction using electromyography	
3	Linear Kinematics of an object in motion and total body center of mass determination	
4	Introduction to linear kinetics and analysis of vertical ground reaction force	
5	Introduction to angular kinematics and range of motion	
6	Analysis of kinetics & kinematics data part 1	
7	Analysis of kinetics & kinematics data part 2	
Midterm Break		
8	Mid Lab Test	Report, Lab Test, Quiz, Viva
9	Biomedical Orthosis/ Prosthesis design & simulation	
10	Study of Ankle Injury Using OpenSim (Both Free Fall & AFO Assisted)	
11	Creating and simulating the computational model of a static body at rest	
12	Creating and simulating the computational model of a dynamic body in motion	
13	Final Lab Test	
14	Quiz and viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (30%)	Report	20%	CO1, CO2, CO3, CO4	C4, C5
	Class Participation	10%	CO1, CO2, CO3, CO4	C4, C5
Final Exam (70%)	Lab Test	35%	CO1, CO2, CO3, CO4	C4, C5
	Quiz	25%	CO1, CO2, CO3, CO4	C4, C5
	Viva	10%	CO1, CO2, CO3, CO4	C4, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Duane Knudson, Fundamentals of Biomechanics, Second Edition, Springer publication, 2007 (UNIT IV)
2. Donald R. Peterson and Joseph D. Bronzino, Biomechanics Principles and applications, CRC Press, Taylor & Francis Group, LLC, 2008 (UNIT II, III)

REFERENCE SITE

https://simtk-confluence.stanford.edu:8443/display/OpenSim/Building+a+Dynamic+Walker+in+Matlab

6.1.15 BME 305 Biomedical Signal Processing

COURSE INFORMATION			
Course Code Course Title	: BME 305 : Biomedical Signal Processing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Math 205: Differential Equation, Laplace Transform and Fourier Transform

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to introduce the fundamental concepts and methods for the characterization and analysis of digital signal and systems with a particular emphasis on the understanding of the basic Biomedical signals and systems.

OBJECTIVE

1. To provide the knowledge about the different processing techniques regarding signal and systems
2. To equip students skilled to apply the knowledge of signal processing to solve the real life problems related to Biosignal.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** signals in the time, frequency, Laplace, and Z domains	C2	1	1	-	1,3	T, F
CO2	Be able to **comprehend** the fundamental signal processing techniques	C2	1	1,3	-	1,3	T, F
CO3	Be able to **acquire** popular biomedical signals and their fundamental features'	C2	2	1	-	1	MID, F
CO4	Be able to **design** and **analyze** the basic processing techniques for the Biomedical signals	C3, C4	3	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Signal and System: Linearity of System, Classification and properties of signals, Common signals in engineering, Continuous-Time (CT) and Discrete-Time (DT) signal and system, Quantization, Analog to digital conversion of signal. **Modeling of Signals and Systems:** Impulse Response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) of Discrete-Time Systems, Difference Equation, Convolution, Correlation, Covariance, Transient and Steady-state Response. **Signal Transformation:** Discrete Fourier Transformation (DFT), Fast Fourier Transformation (FFT), Inverse FFT, Z-Transformation, Inverse Z-Transformation. **Randomness and Estimation of Signals:** Linear Time Invariant (LTI) system, Stationarity and Ergodicity, Power Spectral Density, Frequency and Power Spectrum.

Introduction to Biosignals: Origins, properties and suitable models of popular biosignals, Objectives and challenges of Biosignal Analysis; Steps of Biosignal Processing. **Noise** and **Filters:** Noise Models, Averaging filters, Design and principles of Wiener Filter, FIR and IIR filters. **Biomedical Signal Processing:** Spectral analysis of ECG, EEG, EMG, and EOG signals, Case study on ECG and EMG signals, Introduction to Feature Extractions and Classification.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** signals in the time, frequency, Laplace, and Z domains	3											
CO2	Be able to **comprehend** the fundamental signal processing techniques	3											
CO3	Be able to **acquire** popular biomedical signals and their fundamental features’		3										
CO4	Be able to **design** and **analyze** the basic processing techniques for the Biomedical signals			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Signal and System**	**CT – 1, Final**
Lecture 1	Linearity of System, Classification and properties of signals, Common signals in engineering	
Lecture 2	Continuous-Time (CT) and Discrete-Time (DT) signal and system	
Lecture 3	Quantization, Analog to digital conversion of signal	
2	**Modeling of Signals and Systems**	

Lecture 4	Impulse Response	
Lecture 5	Finite Impulse Response (FIR) of Discrete-Time Systems	
Lecture 6	Infinite Impulse Response (IIR) of Discrete-Time Systems	
3	**Modeling of Signals and Systems**	
Lecture 7	Difference Equation	
Lecture 8	Convolution	
Lecture 9	Correlation, Covariance, Transient and Steady-State Response	
4	**Signal Transformation**	**Midterm, Final**
Lecture 10	Discrete Fourier Transformation (DFT)	
Lecture 11	Fast Fourier Transformation (FFT)	
Lecture 12	Fast Fourier Transformation (FFT)	
5	**Signal Transformation**	
Lecture 13	Inverse FFT	
Lecture 14	Z-Transformation	
Lecture 15	Z-Transformation	
6	**Randomness of Biosignals**	
Lecture 16	Z-Transformation	
Lecture 17	Inverse Z-Transformation	
Lecture 18	Inverse Z-Transformation	
7	**Randomness of Biosignals**	
Lecture 19	Linear Time-Invariant (LTI) system, Stationarity and Ergodicity,	
Lecture 20	Frequency and Power Spectrum	
Lecture 21	Frequency and Power Spectrum	
Midterm Break		
8	**Introduction to Biosignals**	**CT – 2, Final**
Lecture 22	Origins, properties and suitable models of popular biosignals	
Lecture 23	Objectives and challenges of Biosignal Analysis	
Lecture 24	Steps of Biosignal Processing	
9	**Noise and Filters**	
Lecture 25	Noise Model	
Lecture 26	Averaging filters	
Lecture 27	Averaging filters	
10	**Time Domain Filters**	
Lecture 28	Design and principles of Wiener Filter	
Lecture 29	Design and principles of Wiener Filter	
Lecture 30	FIR filters	
11	**Digital Filters**	**CT – 3, FINAL**
Lecture 31	FIR filters	
Lecture 32	Fundamental Design of Window-based FIR filter	
Lecture 33	Fundamental Design of Window-based FIR filter	
12	**Digital Filters**	
Lecture 34	IIR Filter design	
Lecture 35	IIR Filter design	
Lecture 36	Applications of IIR Filters in Biosignals	
13	**Biomedical Signal Processing**	**FINAL**

Lecture 37	Spectral analysis of ECG and EEG signals	
Lecture 38	Spectral analysis of EMG and EOG signals	
Lecture 39	Case study on ECG and EMG signals	
14	**Biomedical Signal Processing**	
Lecture 40	Case study on ECG and EMG signals	
Lecture 41	Introduction to Feature Extractions and Classification	
Lecture 42	Introduction to Feature Extractions and Classification	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C3
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Emmanuel Ifeachor and Barrie Jervis, “Digital Signal Processing: A Practical Approach,” Second Edition, Pearson Publications, 2002.
2. S. R. Devasahayam, “Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling,” Second Edition, Springer Publication, 2013.

REFERENCE BOOKS

1. K J Blinowska and J Zygierewicz, “Practical Biomecial Signal Analysis Using MATLAB,” CRC Press, 2012.
2. Robert B. Northrop, Signals and Systems in Biomedical Engineering, CRC Press, 2003

REFERENCE SITE

6.1.16 BME 306 Biomedical Signal Processing Sessional

COURSE INFORMATION

Course Code	: BME 306	Lecture Contact Hours	: 3.00
Course Title	: Biomedical Signal Processing Sessional	Credit Hours	: 1.50

PRE-REQUISITE

BME 305: Biomedical Signal Processing

CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course aims to prepare students to apply the knowledge of digital signal processing to apply to Biomedical signals for processing and finding the hidden information inside the Biosignals.
OBJECTIVE
1. To perform different signal processing algorithms and techniques to process the Biomedical signals 2. To apply the knowledge of signals processing techniques for the real-life problems regarding the Biomedical signals
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the signal processing related problems and relevant solution techniques in biomedical signals	C2	2		1	1	T, Q, R
CO2	Be able to **apply** the theoretical knowledge of signal processing and **analyze** the biomedical signals	C3, C4	2, 5		1, 3	1, 2	T, Q, R, ASG
CO3	Be able to **evaluate** the meaningful information from the real-life biomedical signals	C5	2, 5		1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT
Sampling, quantization, and representation of different Biosignals, Finite and infinite response determination of a signal, Convolution and its application, Correlation and Covariance of signals with its applications, Determination of DFT, FFT, PSD of the Signal, Z-transformation and inverse Z-transformation, Wiener Filter, Window-based FIR filter, IIR filter, Linear transformation.
SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the signal processing related problems and relevant solution techniques in biomedical signals		3										
CO2	Be able to **apply** the theoretical knowledge of signal processing and **analyze** the biomedical signals		3			3							
CO3	Be able to **evaluate** the meaningful information from the real-life biomedical signals		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	**Lecture Topics**	**Assessment**
1	Introductory Practice on the Fundamentals of Signal Processing in Matlab programming software	Report, Assignment, Lab Test, Viva
2	Experiment on sampling, quantization, and representation of different Biosignals	
3	Experiment on the finite and infinite response determination of a signal	
4	Experiment of Convolution and its application in Biosignal Processing	

5	Investigation on Correlation and Covariance of signals with its applications in Biosignals	
6	Determination of DFT, FFT, PSD of a Biosignal	
7	Experiment on the utilization of Z-transformation and inverse Z-transformation in Biosignal processing	
Midterm Break		
8	Designing a Wiener Filter to remove noises from Biosignals	Report, Lab Test, Quiz, Viva
9	Designing window-based FIR filter for low pass, high pass, and band-pass filters	
10	Designing IIR filter for low pass, high pass, and band-pass filter	
11	Experiment on the linear transformation of Biosignals	
12	Evaluation of the signal processing-based Project given to the students	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Emmanuel Ifeachor and Barrie Jervis, "Digital Signal Processing: A Practical Approach," Second Edition, Pearson Publications, 2002.
2. K J Blinowska and J Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB," CRC Press, 2012.

REFERENCE BOOKS

1. S. R. Devasahayam, "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling," Second Edition, Springer Publication, 2013.

REFERENCE SITE

6.1.17 BME 307 Medical Imaging

COURSE INFORMATION

Course Code Course Title	: BME 307 : Medical Imaging	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 101: Introduction to Biomedical Engineering

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course designs covering the topics/subtopics that help to learn and familiarize the fundamental methodologies of different medical imaging systems including the modality, imaging physics, image construction algorithms, image intervention, and safety measures during imaging.

OBJECTIVE

1. To acquire the rudimentary knowledge about the medical imaging system and its applicative variances.
2. To provide students with an overview of the computational and mathematical methods in medical imaging.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** different types of medical imaging systems and their applications in clinical diagnosis.	C1	2	1	-	1,3	T, F
CO2	Be able to **understand** the fundamental physics and technologies behind different imaging systems.	C2	1	1,3	-	1,3	T, F
CO3	Be able to **apply** the computational techniques to regulate image construction in digital space.	C3	2	1	-	1	MID, F
CO4	Be able to **investigate** the effect of different algorithms in image computation.	C4	4	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Medical Imaging: Non-invasive medical imaging specialty, Medical imaging modalities with applications, Image Characteristics. **X-Ray:** X-ray generation, x-ray generators, Filters, intensifying screens X-radiography, Spatial resolution, Image noise and Image contrast, Introduction to fluoroscopy, Angiography, and mammography, Digital X-ray, Fundamental of Interventional Radiology. **Computed tomography (CT):** Basics of CT scanner system, Radon Transformation for CT imaging, Image reconstruction algorithms: Fourier slice theorem, Fourier Reconstruction, Back-projection Algorithm, Filtered back-projection method, Iterative reconstruction algorithm; CT number, Image artifacts, and Filtering, Evolution of CT from 1G to 5G. **Nuclear Imaging:** Principles of Gamma Camera, Imaging principles of Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), Brief description of PET and SPECT modalities with differences, Safety measures in nuclear imaging.

Magnetic Resonance Imaging (MRI): Evolution of magnetic resonance imaging (MRI) technology and clinical applications, Fundamentals of nuclear magnetic resonance: Angular momentum, magnetic dipole moment, Magnetization, Larmor frequency, Midterm Break, RF and resonance, free induction decay (FID); Different coils and slice selection, spin-echo pulse sequence; Different modes of MRI Images: T1 and T2 Relaxation images, Gradient echo imaging, Diffusion-weighted imaging, etc.; Biological effects of magnetic fields and MRI imaging safety.

Functional Magnetic Resonance Imaging (fMRI): Physics behind hemodynamics and NMR, Principle of imaging, Image Features, and Applications. **Ultrasound Imaging:** Principle of imaging, brief description of modality, Doppler effect, Generation and detection of ultrasound-piezoelectric effect; ultrasonic transducers, Focusing arrays, Transducer beam characteristics: Huygens's principle, beam profiles, pulsed ultrasonic field, Axial and lateral resolution, Far-field and near field concept, Modes of Ultrasound Images, Introduction to Doppler imaging.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **remember** the different types of medical imaging systems and their applications in clinical diagnosis.		3										
CO2	Be able to **understand** the fundamental physics and technologies behind the different imaging systems.	3											
CO3	Be able to **apply** the computational techniques to regulate image construction in digital space.		3										
CO4	Be able to **analyze** the effect of different algorithms in image computation.				4								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to Medical Imaging**	

Lecture 1	Non-invasive medical imaging specialty	**CT – 1, Final**
Lecture 2	Medical imaging modalities with applications	
Lecture 3	Image Characteristics	
2	**X-Ray**	
Lecture 4	X-ray generation, x-ray generators,	
Lecture 5	Filters, intensifying screens X-radiography, Spatial resolution,	
Lecture 6	Image noise and Image contrast	
3	**X-Ray**	
Lecture 7	Introduction to fluoroscopy, Angiography, mammography	
Lecture 8	Principles of digital X-ray (CR and DR)	
Lecture 9	Fundamental of Interventional Radiology	
4	**Computed tomography (CT)**	**Midterm, Final**
Lecture 10	Basics of CT scanner system	
Lecture 11	Radon Transformation	
Lecture 12	Radon Transformation	
5	**Computed tomography (CT)**	
Lecture 13	Fourier slice theorem	
Lecture 14	Fourier Reconstruction	
Lecture 15	Back-projection Algorithm and Filtered back-projection method	
6	**Computed tomography (CT)**	
Lecture 16	Iterative methods for Image reconstruction	
Lecture 17	CT number, Image artifacts, and Filtering	
Lecture 18	Evolution of CT from 1G to 5G.	
7	**Nuclear Imaging**	
Lecture 19	Principles of Gamma Camera) and Imaging principles of Positron Emission Tomography (PET)	
Lecture 20	Single Photon Emission Computed Tomography (SPECT)	
Lecture 21	Brief description of PET and SPECT modalities with differences and safety measures	
Midterm Break		
8	**Magnetic Resonance Imaging (MRI)**	**CT – 2, Final**
Lecture 22	Evolution of magnetic resonance imaging (MRI) technology and clinical applications,	
Lecture 23	Fundamentals of nuclear magnetic resonance: Angular momentum, magnetic dipole moment,	
Lecture 24	Fundamentals of nuclear magnetic resonance: Magnetization, Larmor frequency	
9	**Magnetic Resonance Imaging (MRI)**	
Lecture 25	RF and resonance, free induction decay (FID)	
Lecture 26	Different coils and slice selection	
Lecture 27	T1 and T2 Relaxation images	
10	**Magnetic Resonance Imaging (MRI)**	
Lecture 28	Gradient echo imaging	
Lecture 29	Diffusion weighted imaging	
Lecture 30	Biological effects of magnetic fields and MRI imaging safety	
11	**Functional Magnetic Resonance Imaging (fMRI)**	**CT – 3, FINAL**

Lecture 31	Physics behind hemodynamics and NMR	
Lecture 32	Principle of imaging	
Lecture 33	Image Features and Applications.	
12	**Ultrasound Imaging**	
Lecture 34	Principle of imaging, brief description of modality,	
Lecture 35	Doppler effect; Generation and detection of ultrasound-piezoelectric effect;	
Lecture 36	ultrasonic transducers, Focusing arrays	
13	**Ultrasound Imaging**	**FINAL**
Lecture 37	Transducer beam characteristics: Huygens's principle, beam profiles,	
Lecture 38	Pulsed ultrasonic field, Axial and lateral resolution,	
Lecture 39	Far field and near field concept	
14	**Ultrasound Imaging**	
Lecture 40	Introduction to Doppler imaging	
Lecture 41	Diagnosis process of Ultrasound images, applications, safety measures	
Lecture 42	Future trends in Medical imaging	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO1	C2
			CO2	C3
			CO3	C2
			CO4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. J. T. Bushberg, J. A. Seibert, E. M. Leidholdt JR, and J. M. Boone, The Essential Physics of Medical Imaging, Third Edition, LIPPINCOTT WILLIAMS & WILKINS, 2012.
2. P. Dhawan, H. K. Huang, and D. S. Kim, Principles and Advanced Methods in Medical Imaging and Image Analysis, World Scientific Publishing, 2008.

REFERENCE BOOKS

1. Chris Guy and Dominic Ffytche, An Introduction to The Principles of Medical Imaging, Revised Edition, Imperial College Press, 2005.
2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, Medical Physics and Biomedical Engineering, Medical Science Series, 1999.

REFERENCE SITE

6.1.18 BME 309 Biomedical Transport Phenomenon

COURSE INFORMATION			
Course Code Course Title	: BME 309 :Biomedical Transport Phenomenon	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: BME 205

Course Title: Biofluid Mechanics and Heat Transfer

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the topics that include mass, momentum and heat transport, Basic hemodynamic, equations of continuity and motion, molecular mechanics of fluid and electrolyte transport, Shear stress, mass transfer and metabolism in organs and tissues, compartmental models for pharmacokinetic analyses, analysis of blood oxygenators, Unsteady-state heat transfer modes and laws, heat transfer coefficient, heat transfer inside the body, heat transfer between body and surrounding; Analogy equations relating momentum, energy and mass transfer.

OBJECTIVE

1. This course aims to develop students' basic engineering knowledge of momentum, mass, and heat transfer in integrated form through an array of examples and analysis from biological systems (cellular, tissue, organ levels) and from the design of medical devices.
2. Application of these principles, using quantitative methods based on fundamental physical laws, to solve problems in biology, of clinical significance, and problems in the design and development of medical devices, implants, including tissue-engineered constructs.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** principles of fluid dynamics to model and characterize physiological flow conditions	C3	2	1	-	1,3	T, F
CO2	Be able to **analyze** and **understand** mass transport in biological and living systems	C4	2	1,3	-	1,3	T, F
CO3	Be able to **assess** models of drug transport and delivery in various disease conditions	C5	4	1	-	1	MID, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to mass and momentum in living systems; Basic hemodynamic; Application of momentum balance; Use of the equations of continuity and motion to set up complex flow problems; Conservation relation for fluid transport, dimensional analysis and scaling; Methods for analysing complex physiological flow; Flow in circulatory system and tissue; Flow within distensible tubes; Mass transfer and metabolism in organs and tissues; Diffusion: mass transfer between fluids, membrane and pores; Diffusion with convection or electrical potential; Microscopic and macroscopic mass balances; Transport in porous media; Transvascular transport; Transport of gases between blood and tissue; Analysis of blood oxygenators; Fluid transport in the kidneys; A whole organ approach to renal modelling; Drug transport in solid tumors; Transport in organs and organisms; Compartmental models for pharmacokinetic analyses.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** principles of fluid dynamics to model and characterize physiological flow conditions		3										
CO2	Be able to **analyze** and **understand** mass transport in biological and living systems		3										
CO3	Be able to **assess** models of drug transport and delivery in various disease conditions				3								

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE		
Week	**Topic**	**Assessment**
1	**Introduction to transport fundamentals**	**CT – 1, Final**
Lecture 1	Overview of the transport process and cellular transport	
Lecture 2	Application of transport process in disease pathology	
Lecture 3	An overview of hemodynamics and boundary conditions	
2	**Dimensionless numbers**	
Lecture 4	The Buckingham Pi Theorem and dimensionless numbers	
Lecture 5	Dimensionless numbers in biofluid dynamics	
Lecture 6	Equation of conservation of mass and linear momentum	
3	**Conservation of mass and momentum**	
Lecture 7	Differential continuity equation in rectangular co-ordinates	
Lecture 8	Momentum balance and forces in fluids	
Lecture 9	Euler's, Bernoulli's, and the general form of the Navier-Stokes equation	
4	**Dynamic similarity and introduction to pulsatile flow**	**Midterm, Final**
Lecture 10	Relationship between Navier Stokes and Hagen–Poiseuille equation	
Lecture 11	Dynamic similarity and non-dimensionalizing the Navier-Stokes equation	
Lecture 12	Introduction to oscillating flow in blood vessels	
5	**Pulsatile flow**	
Lecture 13	Velocity profile in pulsatile flow	
Lecture 14	Velocity profile in pulsatile flow	
Lecture 15	Volumetric flow rate in pulsatile flow	
6	**Pulsatile flow continued**	
Lecture 16	Velocity-pressure phase lag in pulsatile flow	
Lecture 17	Womersley number and entrance length in physiological flows	
Lecture 18	Introduction to flow in curved vessels, Dean number and secondary flows	
7	**Flow in curved vessels**	
Lecture 19	Flow separation, adverse pressure gradient, and flow in branching vessels	
Lecture 20	Blood flow and velocity profiles in major arteries	
Lecture 21	Modeling and visualizing blood flow	
Midterm Break		
8	**Transport in Porous Media**	**CT – 2, Final**
Lecture 22	Porosity, Tortuosity, and Volume fraction	
Lecture 23	Fluid flow in porous media	
Lecture 24	Solute transport in porous media	

9	**Mass Transport in Biological System**	
Lecture 25	Conservation and constitutive relation	
Lecture 26	Diffusion, Diffusion coefficient, Steady-state and unsteady diffusion	
Lecture 27	Diffusion-limited reaction	
10	**Diffusion with Convection or Electrical Potential**	
Lecture 28	Fick's law, Dimensional analysis, Electrolyte transport	
Lecture 29	Diffusion and convection, mass transfer coefficients	
Lecture 30	Microscopic and macroscopic mass balances across membranes	
11	**Transport of Gases between Blood and Tissue**	**CT – 3, FINAL**
Lecture 31	Oxygen-Hemoglobin equilibria	
Lecture 32	Dynamics of oxygenation of blood and oxygen delivery in tissue Nitric oxide production and transport in tissue	
Lecture 33	Whole-organ approach to renal modeling	
12	**Drug Transport in Solid Tumors**	
Lecture 34	Introduction to drug delivery in cancer treatment	
Lecture 35	Analysis of transvascular and interstitial fluid transport	
Lecture 36	Interstitial hypertension in solid tumor	
13	**Drug Transport in Solid Tumors, and Pharmacokinetics**	**FINAL**
Lecture 37	Analysis of interstitial transport of solutes	
Lecture 38	Consideration in Pharmacokinetics	
Lecture 39	Compartment models in pharmacokinetic analysis	
14	**Transport in Organs and Organisms**	
Lecture 40	Physiologically based pharmacokinetic models	
Lecture 41	Review	
Lecture 42	Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3	C2, C4
	Class Participation	5%	CO1, CO2, CO3	C2
	Midterm	15%	CO1	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2

Total Marks	100%	

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS
1.Truskey, Yuan, and Katz, Transport Phenomena in Biological Systems, Second Edition, Pearson Education, Inc. 2.Johnson and Ethier, Problems in Biomedical Fluid Mechanics and Transport Phenomena, Cambridge University Press.
REFERENCE SITE

6.1.19 BME 311 Embedded Systems and Interfacing

COURSE INFORMATION			
Course Code Course Title	: BME 311 : Embedded Systems and Interfacing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE
Course Code: CSE 291 Course Title: Computer Programming Course Code: CSE 292 Course Title: Computer Programming Lab Course Code: EECE 391 Course Title: Digital Electronics Course Code: EECE 392 Course Title: Digital Electronics Lab
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
The goal of this course is to expose students to the field of embedded systems and to provide a knowledge foundation which will enable students to pursue a career in relevant fields. Key concepts of hardware-software interfacing control architectures, debugging, and communication protocols will be discussed in this course. Students will be familiar with different firmware architectures and can apply their knowledge in relevant fields such as; clinical device development and robotics in healthcare.
OBJECTIVE
1. To identify and understand fundamentals of microprocessors, microcontrollers, communication protocols and embedded firmware. **2.** To apply the fundamental concepts of embedded engineering **3.** To analyze the various firmware architectures and systems **4.** To evaluate various large scale embedded systems

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** and **understand** the fundamentals of microprocessors,	C1, C2	1,2	1	-	3	T, F

	microcontrollers, communication protocols and embedded firmware.						
CO2	Be able to **apply** the fundamental concepts of embedded engineering.	C3	2	1,3	-	3	T, F
CO3	Be able to **analyze** the various firmware architectures and systems.	C4	2	1	-	5	MID, F
CO4	Be able to **evaluate** various large scale embedded systems	C5	4	1,3	-	5	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Embedded System : Introduction to Embedded Engineering, Chronological development of Firmware and Embedded Technology, Possible Implementation in Healthcare, Review on Digital Techniques : Bit and Bytes, Memory, Number systems, Additions, Subtractions, Multiplications, Boolean Algebra, Divisions, Logic Gates, Combinational Circuits, Decoders, Encoders, Bit and Bytes, Memory, Number systems, Additions, Subtractions, Multiplications, Boolean Algebra, Divisions. **Microprocessors and Microcontrollers:** Flags, Resistors, Processor Types, Processor Architecture, Instruction Sets, Addressing Modes, SAP, 8086 Microprocessors, Memory, Memory Architecture, Virtual Memory, DMA and DMA Controller, AVR and ARM controllers, Overview of Developmental Microcontroller and Microprocessors, Thread, Interrupts, Programmable Timers, Multitasking, Workflow and Architecture of 16 bit/32bit PIC **Firmware Programming:** Assembly Language: Basic Assembly, Bit Operators, Sub Programs, Switch Day, Arrays, Strcuts, Instruction sets, Loops, Conditional Statements. (Higher Level Language; Python: Data Types, python Data Structure, Functions, Object Oriented Programming, Encapsulation, Abstraction, Inheritance, Polymorphism Or C++/objective C: Data Types, Data Structure, Struc, Encapsulation, Abstraction), Inheritance Firmware Architecture, Reset Circuit, Watchdog Timer. **Advanced Systems:** Operating Systems, Real Time OS, Virtual Machine, FPGA, Clustering, Master Slave Topology, Multithread Processors, IoT Architecture, Medical robotics

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** and **understand** the fundamentals of microprocessors, microcontrollers, communication protocols and embedded firmware.	3	3										
CO2	Be able to **apply** the fundamental concepts of embedded engineering.		3										
CO3	Be able to **analyze** the various firmware architectures and systems.		3										
CO4	Be able to **evaluate** various large scale embedded systems				3								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Motivation and course introduction**	**CT – 1, Final**
Lecture 1	Introduction to Embedded Engineering, Chronological development of Firmware and Embedded Technology, Importance of Embedded Engineering in Healthcare	
Lecture 2	Review of Bit and Bytes, Subtractions, Multiplications, Division, Boolean Algebra	
Lecture 3	Review of Logic Gates, Combinational Circuits, Decoders, Encoders	
2	**Introduction to microprocessors**	
Lecture 4	Microprocessor Fundamentals, Types of Processors	
Lecture 5	Processor architecture	
Lecture 6	Simple As Possible (SAP) Architecture	
3	**Microprocessor Fundamentals**	
Lecture 7	Overview of 8086 Microprocessor	
Lecture 8	8086 Microprocessor Instruction sets	
Lecture 9	8086 Microprocessor Addressing Modes	
4	**Basic Embedded Firmware**	**Midterm, Final**
Lecture 10	Assembly Language – 1	
Lecture 11	Assembly Language – 2	
Lecture 12	Assembly Language – 3	
5	**Higher Level Embedded Firmware**	
Lecture 13	Introduction to Data Types, Variable, Operators, If-else, Lists, Functions and basic syntax	
Lecture 14	Object-Oriented Programming	
Lecture 15	Object-Oriented Programming	
6	**Communication Protocols**	
Lecture 16	Intro to Computer Networking and Networking Layers, Bus Interface, I/O Hardware and Interface, Peripheral Interfacing,	

Lecture 17	Wired Communication Protocols (USB, UART, I2C, SPI, CAN)	
Lecture 18	Wireless Communication Protocols (Bluetooth, GSM, ZigBEE, BLE and others)	
7	**Sensors, Actuators and Interfacing**	
Lecture 19	Introduction to Sensors and Actuators, Fundamentals of Sensors and Different Types of Sensors	
Lecture 20	Fundamentals of Actuators and Different Types of Actuators, Interfacing of Sensors and Actuators	
Lecture 21	Interfacing of Sensors and Actuators (Continued)	
	Midterm Break	
8	**Overview of Memory**	**CT – 2, Final**
Lecture 22	Introduction to Memory, Memory Architecture	
Lecture 23	Memory Hierarchy, Memory Interface	
Lecture 24	Virtual Memory, DMA (Direct Memory Access) and DMA Controller	
9	**Threads, Interrupts, Timer and Multitasking**	
Lecture 25	Basic Concepts and Applications of Threads, Overview of Interrupts	
Lecture 26	Introduction to Programmable Timer fundamentals, Fundamental Concepts of Programmable Interrupt Controller,	
Lecture 27	Overview of Multitasking in Microprocessors and Embedded Systems	
10	**Microcontrollers Basics, Microcontroller Architectures and Application**	
Lecture 28	AVR and ARM Microcontrollers	
Lecture 29	Overview PIC Microcontroller	
Lecture 30	Overview PIC Microcontroller (continued)	
11	**Advance Firmware Architecture and Advance Concepts in Embedded Engineering**	**CT – 3, FINAL**
Lecture 31	Reset Circuit , Watchdog Timer, Reliable Architecture in Firmware and system design approaches	
Lecture 32	Reliable Architecture in Firmware and system design approaches (continued)	
Lecture 33	Operating Systems Basics, RTOS, Virtual Machines	
12	**FPGA Boards**	
Lecture 34	Introduction to FPGA Boards	
Lecture 35	Fundamentals of FPGA Boards	
Lecture 36	Applications of FPGA Boards	
13	**Distributed Systems, Artificial Intelligence and IoT Architecture in Embedded Systems**	**FINAL**
Lecture 37	Clustering, Master-Slave Topology, Multithread Processors	
Lecture 38	IoT Architecture and Web Assembly	
Lecture 39	AI Algorithms in microcontrollers and microprocessors	
14	**Embedded Systems in Healthcare, R&D work process and Production Line Designing**	
Lecture 40	Current Trends in Embedded Systems in Healthcare	

Lecture 41	Overview of Robotics in Healthcare, Advanced Surgical Procedures and Medical Device Development	
Lecture 42	R&D work Process and Production Line Designing	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1,C2,C3
	Class Participation	5%	CO1	C1,C2
	Midterm	15%	CO1,CO2	C1,C2,C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
			CO 4	CO 4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Onatham W. Valvano, Brookes/Colem Embedded Mircrocomputer Systems: Real Time Interfacing, Pacific Grove: 2000
2. Charles Marut and Ytha Y. YuAssembly Language Programming and Organization of the IBM PC: McGraw-Hill, 1992. ISBN: 0071128964, 9780071128964

REFERENCE BOOKS

1. Douglas V Hall, Microprocessors and Interfacing
2. Mohamed Rafiquzzaman, Microprocessors and Microcomputer-based System Design, CRC Press, 1995

REFERENCE SITE

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6.1.20 BME 312 Embedded Systems and Interfacing Sessional

COURSE INFORMATION

Course Code Course Title	: BME 312 : Embedded Systems and Interfacing Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 311
Course Title: Embedded Systems and Interfacing
Course Code: CSE 291
Course Title: Computer Programming
Course Code: CSE 292
Course Title: Computer Programming Lab
Course Code: EECE 391
Course Title: Digital Electronics

Course Code: EECE 392
Course Title: Digital Electronics Lab

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of embedded engineering in the domain of biomedical device development and interfacing.

OBJECTIVE

This course aims to enhance students' knowledge on the basic principles of fluid mechanics and heat transfer design problem solution.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** the fundamental concepts of embedded engineering.	C3	2	-	1,3	3	T, Q, R
CO2	Be able to **analyze** the various firmware architectures and systems.	C4	2	-	1	5	T, Q, R, ASG
CO3	Be able to **evaluate** various large scale embedded systems	C5	4	-	1,3	5	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Boolean functions and logic gates, interfacing digital lighting display with microprocessor, stepper motor control with 8086 microprocessor, introduction to developmental boards, stepper motor control with developmental boards, introduction to single board computers, capturing video feedback with single board computers, USB communication, Bluetooth communication, biosignal acquisition with developmental boards and single board computers, implementation of threads, programmable timers, clusters, introduction and overview of 16bit PIC microcontroller, PCB designing.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** the fundamental concepts of embedded engineering.		3										
CO2	Be able to **analyze** the various firmware architectures and systems.		3										
CO3	Be able to **evaluate** various large scale embedded systems				3								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7

Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Implementation of Boolean functions using logic gates	Report, Assignment, Lab Test, Quiz, Viva
2	Interfacing digital lighting display (Dot-matrix) with microprocessor	
3	Stepper Motor Control With 8086 Microprocessor	
4	Introduction to Arduino Development Board and Stepper Motor Control with Arduino Uno	
5	Introduction to Raspberry Pi and Video Feed Capture with Raspberry Pi	
6	USB Communication Between Arduino and Raspberry Pi and Interfacing with Temperature Sensor	
7	PCB Designing in Proteus, Discussion on Project Proposal	
	Midterm Break	
8	Introduction To IoT: Bluetooth Communication and Storing of Data with Raspberry Pi and Arduino	Report, Lab Test, Quiz, Viva
9	Biosignal Acquisition and Display with Arduino and Raspberry Pi Cluster	
10	Implementation of Threads, Programmable Timer with Raspberry Pi-Arduino Cluster and LEDs	
11	Introduction to 16bit PIC Microcontroller and LED Switching with 16 bit PIC Microcontroller	
12	Project Presentation	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C3, C4, C5
	Class Participation	20%	CO1, CO2, CO3	C3, C4, C5
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C3, C4, C5
	Quiz	30%	CO1, CO2, CO3	C3, C4, C5
	Viva	10%	CO1, CO2, CO3	C3, C4, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1.Onatham W. Valvano, Brookes/Colem Embedded Mircrocomputer Systems: Real Time Interfacing, Pacific Grove: 2000

2.Charles Marut and Ytha Y. YuAssembly Language Programming and Organization of the IBM PC: McGraw-Hill, 1992. ISBN: 0071128964, 9780071128964

REFERENCE BOOKS

1.Douglas V Hall, Microprocessors and Interfacing

2.Mohamed Rafiquzzaman, Microprocessors and Microcomputer-based System Design, CRC Press, 1995

REFERENCE SITE

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6.1.21 BME 313 Biomedical Image Processing

COURSE INFORMATION

Course Code Course Title	: BME 313 : Biomedical Image Processing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 305: Biomedical Signal Processing
BME 307: Medical Imaging

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to prepare students to learn the basic knowledge regarding the processing techniques of medical images including filtering, transformation, compression, storage, reconstruction, segmentation, etc. to enhance its quality so that the medical image-based diagnosis process could be aided.

OBJECTIVE

1. To provide knowledge about the different processing techniques regarding medical images.
2. To equip students theoretically skilled in medical image processing to solve the real-life problem related to imaging-based clinical diagnosis.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** different steps of biomedical image processing steps and their applications in clinical diagnosis.	C1	1	1	-	1,3	T, F
CO2	Be able to **understand** the fundamental image processing technique.	C2	1	1,3	-	1,3	T, F
CO3	Be able to **apply** the basic image processing techniques with a modified form to medical images.	C3	5	1	-	1	MID, F
CO4	Be able to **analyze** the medical image related to real-life problems and possible processing techniques for aiding diagnosis.	C4	2	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Origin of Medical Images and Processing: Medical image sources, Properties, Processing challenges, Processing steps, Image representation, Hardware, and software requirements. **Image as Two-dimensional (2D) systems:** Image as a 2D signal, 2D sequences, and systems, Vector-space image representation, superposition and convolution, 2D Sampling theory, Image quantization, Image perception, Smoothing & Sharpening, Spatial filtering, Quality measures. **Image Transforms:** 2D Fourier Transform, Sine and Cosine transformation, Hadamard transformation, Slant, and KL transformation. **Colors in Image:** Concept of monochrome and color images, Color Fundamentals, Color Models, Pseudo Color Image Processing, Basics of Full-Color Image Processing, Color Transformations.

Image Enhancement: Image Enhancement in spatial domain: Gray Level Transformations, Histogram Processing, Smoothing and Sharpening Spatial Filters; Image Enhancement in the frequency domain: Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters. **Image Reconstruction:** Reconstruction concept of medical images, Image reconstruction in X-Ray, Image reconstruction in CT, Fourier slice theorem, Back projection algorithm for parallel projection data, Filtered-back projection algorithm, Image Reconstruction in Magnetic Resonance Imaging, Image Reconstruction in Ultrasound Imaging. **Image segmentation:** Feature Extraction, Edge Detection, Boundary Extraction, Region Representation, Moment Representation, Shape Features, Scene Matching Image Segmentation, Threshold-based segmentation, Region growing segmentation, Active contour model for segmentation.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** different steps of biomedical image processing steps and their applications in clinical diagnosis.	3											
CO2	Be able to **understand** the fundamental image processing technique.	3											
CO3	Be able to **apply** the basic image processing techniques with the modified form to medical images.					3							
CO4	Be able to **analyze** the medical image related to real-life problems and possible processing techniques for aiding diagnosis.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Origin of Medical Images and Processing**	**CT – 1, Final**
Lecture 1	Medical image sources, Properties	
Lecture 2	Processing challenges, Processing steps	
Lecture 3	Image representation, hardware and software requirements	
2	**Image as Two-dimensional (2D) systems**	
Lecture 4	Image as a 2D signal, 2D sequences, and systems	
Lecture 5	Vector-space image representation	
Lecture 6	superposition and convolution	
3	**Image as Two-dimensional (2D) systems**	
Lecture 7	2D Sampling theory, Image quantization, Image perception	
Lecture 8	Smoothing & Sharpening, Quality measures	
Lecture 9	Spatial filtering	

4	**Image Transforms**	**Midterm, Final**
Lecture 10	2D Fourier Transform	
Lecture 11	Sine transformation	
Lecture 12	Cosine transformation	
5	**Bio-image compression algorithms**	
Lecture 13	Hadamard Transformation	
Lecture 14	Slant Transform	
Lecture 15	KL Transform	
6	**Colors in Image**	
Lecture 16	Concept of monochrome and color images	
Lecture 17	Color Fundamentals	
Lecture 18	Color Models	
7	**Colors in Image**	
Lecture 19	Pseudo Color Image Processing	
Lecture 20	Basics of Full-Color Image Processing	
Lecture 21	Color Transformations	
Midterm Break		
8	**Image Enhancement (Spatial Domain)**	**CT – 2, Final**
Lecture 22	Gray Level Transformations, Histogram Processing	
Lecture 23	Smoothing Spatial Filters	
Lecture 24	Sharpening Spatial Filters	
9	**Image Enhancement (Frequency Domain)**	
Lecture 25	Smoothing Frequency-Domain Filters	
Lecture 26	Smoothing Frequency-Domain Filters	
Lecture 27	Sharpening Frequency Domain Filters	
10	**Image Reconstruction**	
Lecture 28	Reconstruction concept of medical images	
Lecture 29	Image reconstruction in X-Ray	
Lecture 30	Image reconstruction in CT	
11	**Image Reconstruction**	**CT – 3, FINAL**
Lecture 31	Fourier slice theorem	
Lecture 32	Back projection algorithm for parallel projection data	
Lecture 33	Filtered-back projection algorithm	
12	**Image Reconstruction**	
Lecture 34	Image Reconstruction in Magnetic Resonance Imaging	
Lecture 35	Image Reconstruction in Ultrasound Imaging	
Lecture 36	Feature Extraction	
13	**Image segmentation**	**FINAL**
Lecture 37	Edge Detection, Boundary Extraction	
Lecture 38	Region Representation, Moment Representation	
Lecture 39	Shape Features, Threshold-based segmentation	
14	**Image segmentation**	
Lecture 40	Scene Matching Image Segmentation	
Lecture 41	Region growing segmentation,	
Lecture 42	Active contour model for segmentation	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO1	C2
			CO2	C3
			CO3	C2
			CO4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson, 2017.
2. Atam P. Dhawan, Medical Image Analysis, Second Edition, IEEE Series in Biomedical Engineering, 2011.

REFERENCE BOOKS

1. Jiri Jan, Medical Image Processing, Reconstruction and Restoration: Concept and Method, Taylor and Francis Publisher, 2006.

REFERENCE SITE

6.1.22 BME 314 Biomedical Image Processing Sessional

COURSE INFORMATION

Course Code Course Title	: BME 314 : Sessional on Biomedical Image Processing	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

BME 307: Medical Imaging

BME 313: Biomedical Image Processing

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to furnish students' knowledge of Medical Imaging and Biomedical Image Processing including quality assurance, quality control, calibration, and maintenance of medical imaging devices, as well as the reconstruction and processing of medical images.

OBJECTIVE

1. To perform the quality assurance, quality control, calibration, and maintenance of medical imaging modalities
2. To process the problems regarding the medical image reconstruction and quality enhancement

COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the procedure of quality assurance quality control, calibration and maintenance of medical imaging modalities practically.	C2	1	-	1	1	T, Q, R
CO2	Be able to **apply** and **analyze** the construction and processing mechanism of the medical images.	C3, C4	2	-	1, 3	1, 2	T, Q, R, ASG
CO3	Be able to **apply** different algorithms to the medical images to solve imaging-based diagnosis	C2	5	-	1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Medical Imaging, their modalities, and the relevance to Biomedical Engineering, Observation the imaging techniques of different medical imaging modalities and learning about quality control system as per guideline of IAE and NCRT, Fundamental image processing techniques by MATLAB, Processing techniques of an X-ray Image, Radon transformation and Sinogram for the CT Imaging, Back projection algorithm to reconstruct CT image, Image Segmentation, Case study on medical images to improve the image quality for aiding diagnosis.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the procedure of quality assurance quality control, calibration, and maintenance of medical imaging modalities practically.	3											
CO2	Be able to **apply** and **analyze** the construction and processing mechanism of the medical images.		3										
CO3	Be able to **apply** different algorithms to the medical images to solve imaging-based diagnosis					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	

Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to Medical Imaging, their modalities, and the relevance to Biomedical Engineering	Report, Assignment, Lab Test, Viva
2	A study tour to a medical imaging center to observe the imaging techniques of X-ray and CT and learning about quality control system as per guideline of IAE and NCRT.	
3	A study tour to a medical imaging center to observe the techniques of MRI and Ultrasound imaging and learning about quality control system as per guideline of IAE and NCRT.	
4	A study tour to a medical imaging center to observe the techniques of Nuclear Imaging and learning about quality control system as per guideline of IAE and NCRT.	
5	Introductory practice on the fundamental image processing techniques by MATLAB	
6	Experiment on the processing techniques of an X-ray Image	
7	Experiment on the Radon transformation and Sinogram for the CT Imaging	
	Midterm Break	
8	Design and implementation of the back-projection algorithm to reconstruct CT image	Report, Lab Test, Quiz, Viva
9	Experiment on the segmentation of the brain MRI images	
10	Case study on image processing to improve the image quality for aiding diagnosis.	
11	Case study on image processing to improve the image quality for aiding diagnosis.	
12	A project show based on medical image processing by the students	

13	Final Lab Test	
14	Quiz/Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1.Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson, 2017.
2.Atam P. Dhawan, Medical Image Analysis, Second Edition, IEEE Series in Biomedical Engineering, 2011.

REFERENCE BOOKS

1.Jiri Jan, Medical Image Processing, Reconstruction and Restoration: Concept and Method, Taylor and Francis Publisher, 2006.

REFERENCE SITE

6.1.23 BME 315 Biomaterials

COURSE INFORMATION

Course Code Course Title	: BME 315 : Biomaterials	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

CHEM 103 – **General Chemistry**; CHEM 125 – Physical and Bio-organic Chemistry; BME 203– Biochemistry

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers the following modules: Structure of solids, characterization of biomaterials, metallic implant materials, ceramic implant materials, synthetic polymeric materials, composite biomaterials and material-tissue interactions, sterilization of biomaterials, structure and function of natural biomaterials.

OBJECTIVE

1. To introduce students to different implants, prosthetic and functional materials, investigate the materials' properties including their designs and applications.
2. To investigate both synthetic and natural polymers, and explore biomaterial-tissue interaction in detail with a focus on applications in tissue engineering and cardiology.

COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** different types of biomaterials	C2	2	-	-	1	T, MID
CO2	Be able to **understand** and **analyze** the properties of biomaterials	C2	1	-	-	1	T, MID, F
CO3	Be able to **comprehend** the interactions of cell and tissues with biomaterials based on biomaterial properties and reactivity	C5	4,2	-	3	1	MID, F
CO4	Be able to **design** and **apply** different types of biomaterials to solve biomedical problems	C3	3	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The structure of solid: Structure of solids overview, classification of solids, classification of solids based on structure, lattice imperfections and defects

Properties and Characterization of Materials: Thermal properties phase diagrams, strengthening by heat treatments, surface properties and adhesion. Electrical properties, optical properties, x-ray absorption, acoustic and ultrasonic properties, density and porosity and diffusion properties, XPS, XRD, spectroscopy, SFM, AFM, optical characterization of biomaterials

Metallic Biomaterials: Stainless steels, co-based alloys, Ti and Ti-based alloys, dental metals, other metals, corrosion of metallic implants.

Ceramic Implant Materials: Structural property relationship of ceramics, aluminum oxides (alumina), zirconium oxides (zirconia), calcium phosphate, glass ceramics, other ceramics, carbons, deterioration of ceramics.

Synthetic Polymeric Material: Basic structure, classifications (thermoplasts, thermoset, and elastomers), different physical and mechanical properties, and various uses of biomaterials. Natural polymeric materials, biodegradable polymers, applications and functions

Composites as Biomaterials: Structure, mechanics of composites, applications of composite biomaterials, biocompatibility of composite, biomaterials.

Biological response to biomaterials: biocompatibility, toxicity of biomaterials, host response of biological materials to biomaterials, sterilization of biomaterials, applications of biomaterials in cardiology and tissue engineering

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** different types of biomaterials		3										
CO2	Be able to **understand** and analyze the properties of biomaterials	3											
CO3	Be able to **comprehend** the interactions of cell and tissues with biomaterials based on biomaterial properties and reactivity		3		3								
CO4	Be able to **design** and **apply** different types of biomaterials to solve biomedical problems			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Course Introduction and the structure of solids**	**CT – 1 and Midterm, Final**
Lecture 1	Introduction to biomaterials	
Lecture 2	Classification of biomaterials	
Lecture 3	Atomic bonding and the structure of solids	
2	**Structure of solids**	
Lecture 4	Crystal structure: crystalline and non-crystalline materials	
Lecture 5	Imperfections in crystalline structures	
Lecture 6	Mechanical testing methods, tensile and compression properties of biomaterials	
3	**Mechanical properties and characterization of biomaterials**	
Lecture 7	Shear properties, stress-strain properties and analysis of biomaterials	

Lecture 8	Bending properties, creep, fatigue, and stress relaxation of biomaterials	
Lecture 9	Thermal processing and properties of biomaterials	
4	**Phase diagram**	**Midterm, Final**
Lecture 10	Basic concepts of phases and microstructure	
Lecture 11	Iron-Iron Carbide phase diagram	
Lecture 12	Phase transformation	
5	**Physical Properties of Biomaterials**	
Lecture 13	Electrical properties of biomaterials	
Lecture 14	Optical properties of biomaterials	
Lecture 15	X-ray diffraction, ultrasonic, and acoustic properties	
6	**Characterization of biomaterials**	
Lecture 16	Spectroscopic analysis of biomaterials	
Lecture 17	Surface characterization of biomaterials -AFM, SFM, SEM, and optical techniques	
Lecture 18	Introduction to metallic biomaterials - stainless steel and Co-Cr based alloys	
7	**Metallic biomaterials**	
Lecture 19	Titanium and Titanium based alloys	
Lecture 20	Corrosion of metallic implants	
Lecture 21	Revision	
MIDTERM		
8	**Ceramic Biomaterials**	**CT – 2, FINAL**
Lecture22	Structure property relationship of ceramics	
Lecture 23	Aluminum Oxides (Alumina) & Zirconium Oxides (Zirconia)	
Lecture 24	Glass ceramics	
9	**Polymeric biomaterials**	
Lecture 25	Structure and classification of polymeric materials	
Lecture 26	Properties and processing of polymeric materials	
Lecture 27	Natural polymeric materials – properties and functions	
10	**Polymeric biomaterials**	
Lecture 28	Hydrogel – properties, functions and applications	
Lecture 29	Biodegradable polymers – properties, functions and applications	
Lecture 30	Polymeric biomaterials in biosensors	
11	**Composite biomaterials and Biocompatibility**	
Lecture 31	Structure and anisotropy of composites	
Lecture 32	Fibrous and particulate composites	
Lecture 33	Biocompatibility of biomaterials	
12	**Biological response to biomaterials**	**CT – 3, FINAL**
Lecture 34	Protein-biomaterial interactions	
Lecture 35	Cell/tissue-biomaterial interactions	
Lecture 36	Toxicity and immune response	
13	**Soft tissue replacement**	
Lecture 37	Sutures, surgical tapes, and adhesives	
Lecture 38	Percutaneous and skin implants	
Lecture 39	Cardiovascular grafts and stents	

14	**Hard tissue replacement**	
Lecture 40	Fracture and spinal plates	
Lecture 41	Dental restorations and implants	
Lecture 42	Revision	
	FINAL EXAMINATION	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2
	Class Participation	5%	CO2	C4
	Midterm	15%	CO1, CO2	C2, C4
Final Exam		60%	CO 1	C2
			CO 2	C4
			CO 3	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Biomaterials, Joyce Y Wong, Joseph D Bronzino, CRC Press (latest edition)
2. Biomaterials: An Introduction, 3rd Edition by Joon Park R.S. Lakes

REFERENCE BOOKS

1. Materials Science and Engineering - An Introduction, 4th Ed,WD Callister, Jr. and David G. Rethwisch

REFERENCE SITE

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6.1.24 BME 316 Biomaterials Sessional

COURSE INFORMATION

Course Code Course Title	: BME 316 : Biomaterials Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 303

Course Title: Biomaterials

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the characterization of mechanical, physical, and chemical properties, such as young's modulus, ductility, porosity, corrosion, and surface topography of biomaterials.

OBJECTIVE

This course aims to introduce students to biomaterial testing and the factors influencing their functions.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **investigate** different biomaterials to determine their mechanical strength properties	C4	4		1	1, 2	T, Q, R
CO2	Be able to **synthesize** polymeric biomaterials and characterize their physical and chemical properties	C4	4		1	1, 2	T, Q, R
CO3	Be able to **design, develop and test** synthetic biomaterials for biomedical applications.	C6	3,10		1	5	PR, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Determination of elasticity and Young's modulus, stress and strain analysis, tensile test, compressive test, bending test, impact test, corrosion test, microscopic analysis, surface topography and porosity, hydrogel and composite biomaterial fabrication, bone cement preparation, spectrophotometric and FTIR characterization of biomaterials.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to investigate different biomaterials to determine their mechanical strength properties				3								
CO2	Be able to synthesize polymeric biomaterials and characterize their physical and chemical properties				3								
CO3	Be able to **design, develop and test** synthetic biomaterials for biomedical applications.			3							2		

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to biomaterials lab, laboratory techniques, laboratory rules. Introduction to polymer biomaterials	Report, Lab Test, Quiz, Viva
2	Preparation and synthesis of hydrogel	
3	Physical property and qualitative assessment of the hydrogel. Preparation of hydrogel for lyophilization and degradation test	
4	Analysis of the lyophilized hydrogel and water absorption test Measurement of the degradation test	
5	Measurement of water absorption test and degradation test Preparation for FTIR analysis and tensile test	
6	FTIR analysis of hydrogels	
7	Tensile testing of hydrogels	
	Midterm Break	
8	Lab Test 1	Report, Lab Test, Quiz, Viva
9	Preparation and fabrication of bone cement	
10	Compression analysis of bone cement	
11	Three point bending of bone cement/other relevant composite/biological materials	

12	UV-VIS spectrophotometry analysis of different concentrations of solutions	Project, Presentation
13	Optical property measurement of different materials	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (30%)	Report	20%	CO1, CO2	C4
	Class Participation	10%	CO1, CO2, CO3	C4, C6
Final Exam (70%)	Lab Test	15%	CO1, CO2	C4
	Project	15%	CO3	C6
	Quiz	30%	CO1, CO2	C4
	Viva	10%	CO1, CO2	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Elements of Materials Science and Engineering 6th Edition. by L. H. Van Vlack

REFERENCE SITE

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6.1.25 BME 318 Biomedical Engineering Design Sessional I

COURSE INFORMATION			
Course Code Course Title	: BME 318 : Biomedical Engineering Design Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
PRE-REQUISITE			
Course Code: BME 104 Course Title: CAD in Biomedical Engineering Sessional			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
This course covers the application of design tools to model prototypes and develop the individual project ideas and full completion of an individual project.			
OBJECTIVE			
The aim of this course is to enhance student's idea about project and develop their capabilities of project management.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** modern engineering tools to develop projects to enhance healthcare facilities.	C3	3, 5	1	-	1	T, Q, R
CO2	Be able to **analyze** a complex problem and using engineering tools and knowledge would be able to formulate a suitable solution.	C4	2, 5	1	-	1, 2	T, Q, R, ASG
CO3	Be able to **design** and develop devices and equipment to improve healthcare facilities.	C6	3	1, 3	-	5	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

The course introduces students to the fundamental fabrication techniques utilized in biomedical engineering research and medical device production. In the first 7 weeks students are given hands-on training on a range of techniques such as FDM printing, SLA printing, PCB design and fabrication, CNC milling, laser cutting, and PDMS microfabrication. Students are then given specific design challenges which they will address utilizing the relevant design principals. Design challenges are directed by the course instructor(s) and may include topics ranging from instrumentation to prosthetic/orthotic development.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** modern engineering tools to develop projects to enhance healthcare facilities.			2		3							
CO2	Be able to **analyze** a complex problem and using engineering tools and knowledge would be able to formulate a suitable solution.		2			3							
CO3	Be able to **design** and develop devices and equipment to improve healthcare facilities.			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to biomedical design, group formation, and directed development of a sample prototype in relevant design software	Report, Assignment, Lab Test, Quiz, Viva
2	Prototype printing using Stereolithography printing (SLA) and analysis of the printed model	
3	Designing an electrical circuit using CNC milling	
4	Designing an electrical circuit using a PCB printer	
5	Creation of micro-channels on acrylic using laser cutter	
6	Fabrication, inspection and assembly of PDMS microchannels	
7	Mid-term quiz and launching of design challenge	

Midterm Break		
8	Brainstorming feasible solutions to the design challenge	Report, Lab Test, Quiz, Viva
9	Prototype development	
10		
11	Prototype measurement and characterization	
12	Prototype testing and validation	
13	Presentation and project showcasing	
14	Project Submission with complete documentation (Drawing, user manual, report and design history file)	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Robbinson C.J., Rehabilitation Engineering. CRC press 1995
2. Gerald E. Miller, Artificial Organs, Morgan & Claypool Publishers, 2006

REFERENCE BOOKS

1. Bronzino. Joseph, Handbook of biomedical engineering. CRC; 2 Sub editions, 1999
2. BallabioE.etal, Rehabilitation Engineering. IOS press 1993.

REFERENCE SITE

6.1.26 BME 300 Industrial Training

COURSE INFORMATION

Course Code Course Title	: BME 300 : Industrial Training	Lecture Contact Hours Credit Hours	: 1.50 : 1.50

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

Training in industry, hospital or healthcare organization will be conducted for a duration of 4 weeks at the end of level 3 term 2. Students will learn how to apply their skills as a biomedical engineer in a professional setting and will undergo extensive training in preparation for their role in the industry, hospital, or healthcare facilities. The training can be arranged by the department.

OBJECTIVE

1. To learn and explore the different technical aspects and management of health-related organizations.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the role of a biomedical engineer in their respective fields	C2	6, 12	-	7	7	R, Pr
CO2	Be able to **evaluate** various technical aspects of biomedical equipment	C5	9, 10	2	-	7	R, Pr
CO3	Be able to **learn** and **apply** professional ethics, responsibilities and the norms of the engineering practice.	C3	8, 12	-	7	7	R, Pr
CO4	Be able **to comprehend** and **write** effective reports, design documentation, make effective presentations and give and receive clear instructions.	C6	10	-	-	7	R, Pr
CO5	Be able to **apply** their biomedical engineering knowledge in a professional setting	C3	9, 11, 12	1	-	6	R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

4 weeks of industrial training at an industry, hospital, or healthcare organization. This is obligatory for the completion of B.Sc. course. An evaluation report from the industry is to be submitted at the end of the training and accordingly to be incorporated in the tabulation sheet.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the role of a biomedical engineer in their respective fields						3						3
CO2	Be able to **evaluate** various technical aspects of biomedical equipment									2	3		
CO3	Be able to **learn** and **apply** professional ethics, responsibilities and the norms of the engineering practice.								3				3
CO4	Be able **to comprehend** and **write** effective reports, design documentation, make effective presentations and give and receive clear instructions.										3		

CO5	Be able to **apply** their biomedical engineering knowledge in a professional setting									3		3	3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	2
Final Presentation	1
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method, Training.

COURSE SCHEDULE

Week	**Content**	**Assessment**
1	Industrial Training at an industry, hospital, or healthcare organization	**Continuous Assessment, Report**
2	Industrial Training at an industry, hospital, or healthcare organization	
3	Industrial Training at an industry, hospital, or healthcare organization	
4	Industrial Training at an industry, hospital, or healthcare organization	
Final Presentation		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C2, C3, C5
	Class Participation	20%	CO1, CO2, CO3	C2, C3, C5
Final Exam (60%)	Final Presentation	60%	CO1, CO2, CO3	C2, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

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REFERENCE SITE

COURSE INFORMATION

Course Code Course Title	: BME 301 : Statistics and Numerical Methods for Biomedical Engineers	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: MATH 205
Course Title: Differential Equation, Laplace Transform and Fourier Transform

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To teach the students the basic concepts and principles of numerical methods and statistics. It is targeted to provide a basic foundation for mathematics areas such as various numerical approximations of linear equations and DEs etc. Finally, this course is designed to develop the capability of solving real- life problems through Numerical methods and giving statistical interpretation and comments.

OBJECTIVE

1. Be able to understand the basic knowledge of various numerical approximations for solving equations.
2. Be able to provide a statistical probability of any real-life problem.
3. Implement numerical methods and statistical concepts in solving different engineering problems.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** different numerical methods.	C2	1	1		1	T, F, ASG
CO2	Be able to **identify** and **analyze** statistical data and probability concepts.	C2	2	1		1,2	T, MT, F, ASG

CO3	Be able to **apply** numerical methods, sampling theory and different statistical tests to solve real-world problems.	C3	5	1		1,2	MT, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; MT– Midterm Exam; ASG – Assignment; F – Final Exam)

COURSE CONTENT

Numerical Methods For Biomedical Engineering:

Numerical Solution of Algebraic and Transcendental Equations: Introduction, Bisection method, Newton-Raphson method. Solution of system of linear equations using direct and iterative method.

Interpolation: Finite differences, Forward and backward differences, Difference table, difference of polynomial. Newton forward and backward interpolation formula, Central and divided differences, Numerical Integration Numerical solution of ordinary differential equations.

Statistics:

Correlation: Scatter diagrams, Correlation co-efficient, Rank correlation, Correlation ratio, Theorems on correlations.

Regression Analysis: Linear regression, Equation of the line of regression, Regression co-efficient, Curve fitting, Method of least square.

Probability: Mathematical and statistical definitions, Additive and multiplicative rule of probability, Conditional probability, Baye's theorem, joint probability.

Random Variables: Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution functions, Mathematical expectation.

Discrete Probability Distribution: Binomial distribution, Negative binomial distribution, Geometric distribution, Poisson's distribution.

Continuous Probability Distribution: Normal distribution, Exponential distribution, Chi-square distribution, t and F- distributions.

Sampling Distribution: Population, Sample mean, Sample variance, Central limit theorem, Sampling distribution from a normal population.

Test of Hypothesis: Statistical hypothesis, Level of significance, Type I and Type II error, One tailed and two tailed tests, Tests for proportions.

Analysis of Variance: One way and Two classification of ANOVA

SKILL MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** different numerical methods.	3											
CO2	Be able to **identify** and **describe** statistical data and probability concepts.		3										
CO3	Be able to **Apply** numerical methods, sampling theory and different statistical tests to solve real-world problems.					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for CO-PO mapping:

Mapping	Corresponding Level of matching	Justifications
CO1-PO1(a)	**3**	The knowledge of mathematics has to be applied to understand different numerical methods in the field of engineering study.
CO2-PO1(a)	**3**	In order to identify and describe statistical phenomena and probability distribution, using the knowledge of mathematics and sciences is required.
CO3-PO1(a)	**3**	Interpret various numerical methods and statistical phenomena to solve DEs using them, the knowledge of mathematics is required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Week 1	**Numerical Analysis**	
Class 1	**Numerical Solution of Algebraic and Transcendental Equations**: Introduction	**CT 1**
Class 2	Bisection method	
Class 3	Newton-Raphson method	
Week 2	**Numerical Analysis**	
Class 4	Solution of system of linear equations using direct method	
Class 5	Solution of system of linear equations using iterative method	
Class 6	**Interpolation**: Finite differences, Forward differences	
Week 3	**Numerical Analysis**	
Class 7	**Interpolation**: Finite differences, backward differences	
Class 8	Central differences, Divided differences, Difference table	
Class 9	Central differences, Divided differences, Difference table	
Week 4	**Numerical Analysis**	**CT 2**
Class 10	difference of polynomial	
Class 11	Newton interpolation formula	
Class 12	Newton forward interpolation formula, Newton backward interpolation formula	

Week 5	**Numerical Analysis**	
Class 13	Numerical Integration	
Class 14	Numerical solution of ordinary differential equations	
Class 15	Application of numerical methods in Biomedical Engineering	
Week 6	**Statistics**	
Class 16	Introduction to statistics, correlation: Scatter diagrams, Correlation co-efficient	
Class 17	Rank correlation, Correlation ratio, Theorems on correlations.	
Class 18	**Regression Analysis**: Linear regression	
Week 7	**Statistics**	**Mid Term**
Class 19	Least square method Equation of the line of regression	
Class 20	Regression co-efficient, Curve fitting	
Class 21	**Probability:** Mathematical and statistical definitions, Additive and multiplicative rule of probability	
Week 8	**Statistics**	
Class 22	Conditional probability, Joint Probability, Baye's theorem	
Class 23	Conditional probability, Joint Probability, Baye's theorem	
Class 24	**Random Variables:** Discrete and continuous random variables,	
Week 9	**Statistics**	
Class 25	Random Variable: Probability mass function	
Class 26	Probability density function, Cumulative distribution functions	
Class 27	Mathematical expectation.	
Week 10	**Statistics**	**CT 3**
Class 28	**Discrete Probability Distribution:** Binomial distribution,	
Class 29	Negative binomial distribution, Geometric distribution	
Class 30	Poisson's distribution.	
Week 11	**Statistics**	
Class 31	**Continuous Probability Distribution**: Normal distribution: Introduction	
Class 32	**Continuous Probability Distribution**: Normal distribution: Theory	
Class 33	**Continuous Probability Distribution**: Normal distribution: Example	
Week 12	**Statistics**	
Class 34	Exponential distribution, Chi-square distribution, t and F- distributions	
Class 35	**Sampling Distribution**: Population, Sample mean, Sample variance	
Class 36	Central limit theorem, Sampling distribution from a normal population.	
Week 13	**Statistics**	
Class 37	**Test of Hypothesis**: Statistical hypothesis, Level of significance, Type I and Type II error	
Class 38	One tailed and two tailed tests, Tests for proportions.	
Class 39	Effect size Cohen's D method	
Week 14	**Statistics**	
Class 40	Analysis of Variance (ANOVA): One tailed and Two tailed tests	
Class 41	Analysis of Variance: Example	
Class 42	Statistical applications in Biomedical Engineering	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C2
			CO3	C3
	Class Participation	5%	CO1, CO2, CO3	C2, C3
	Midterm	15%	CO 2, CO3	C2, C3
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Numerical analysis, Walter Gautschi
2. Probability and Statistics for Engineers, Scheaffer & McClave.

REFERENCE BOOKS

1. Introduction to Statistics for Biomedical Engineers, Kristina M. Ropella
2. Business Statistics, Gupta and Gupta.

REFERENCE SITE

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COURSE INFORMATION

Course Code Course Title	: BME 302 : Statistics and Numerical Methods for Biomedical Engineers Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 301

Course Title: Statistics and Numerical Methods for Biomedical Engineers

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

A biomedical engineer or researcher has to deal with different form of complex computational problems in his/her academic and professional life. Besides, from a large scale computation and analysis different forms of statistical decisions are to make by the biomedical engineers and researchers. To make these sorts of numerical and statistical computations simpler, faster, more efficient and accurate, learning about well-known statistical and numerical methods are obligatory. This laboratory coursework includes some of these statistical and numerical techniques like regression, curve fitting, interpolation, root finding, numerical calculus, solving linear and non-linear equations, higher order statistical measures, different statistical distributions, hypothetical tests, etc. This course covers the application of the statistical and numerical methods to solve the real-life problems using computer programming language like MATLAB, Python, R, etc.

OBJECTIVE

To develop students' skill of applying different statistical and numerical methods to solve real-life biomedical engineering problems utilizing the analytical tools like MATLAB, Python, R, etc.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** and **apply** different statistical techniques to solve the related problems.	C3, C4	2, 5	-	-	1	T, Q, R
CO2	Be able to **analyze** and **apply** different numerical methods to solve real-life mathematical problems.	C3, C4	2, 5	-	-	1	T, Q, R
CO3	Be able to **compare** between different statistical and numerical techniques to conclude about the suitable technique for efficient and accurate results.	C5	2, 5	-	-	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to MATLAB/Python/R; Curve fitting problems and solutions using Linear Regression, Polynomial Regression, and Lagrange's Interpolation formula; Numerical root finding approach using Bisection Method, False Position Method, and Newton-Raphson Method; Numerical differentiation; Numerical integration; Finding the solutions of a linear system; Finding the concept of lower and higher order moments of random variables; Familiarization to the Probability, Conditional Probability, and Joint Probability, and the implementation techniques of Histogram, PDF's, CDF's of random variables, Binomial Distribution, Negative Binomial Distribution, Geometric Distribution, Normal Distribution and Poisson's distribution; Overview on the Statistical Hypothesis Test and execution of z-test, t-test, and Chi-Square ($\chi 2$) test for the statistically hypothetical decision making on Biomedical data; One-way and Two-way Analysis of Variances (ANOVA) for the statistical significance test of Biomedical data.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** and **apply** different statistical techniques to solve the related problems.		3			3							
CO2	Be able to **analyze** and **apply** different numerical methods to solve real-life mathematical problems.		3			3							
CO3	Be able to **compare** between different statistical and numerical techniques to conclude about the suitable technique for efficient and accurate results.		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to Statistics and Numerical Analysis Tools (MATLAB/Python/R)	Report, Lab Test, Quiz, Viva
2	Introduction to curve fitting problems related to Biomedical Engineering and their solutions using Linear Regression, Polynomial Regression, and Lagrange's Interpolation formula.	

3	Numerical approach to find the root of a non-linear equation using Bisection Method, False Position Method, and Newton-Raphson Method.	
4	Numerical differentiation using Forward Difference and Backward Difference approaches.	
5	Numerical integration using Trapezoidal, Simpson's (1/3), and Simpson's (3/8) rules.	
6	Finding the solutions of a linear system (a set of equations with multiple variables) using Gauss-Jordan Elimination through Pivoting and Gauss-Siedel Iterative methods.	
7	Lab Quiz	
Midterm Break		
8	Introduction to the random variables in biomedical engineering problems and the concept of method of moments to find lower and higher order moments of random variables.	Report, Lab Test, Quiz, Viva
9	Familiarization to the Probability, Conditional Probability, and Joint Probability, and the implementation techniques of Histogram, PDF's, CDF's of random variables.	
10	Familiarization and Implementation of Binomial Distribution, Negative Binomial Distribution, Geometric Distribution, Normal Distribution and Poisson's distribution.	
11	Overview on the Statistical Hypothesis Test and execution of z-test, *t*-test, and Chi-Square (χ^2) test for the statistically hypothetical decision making on Biomedical data.	
12	A gentle introduction to the execution of One-way and Two-way Analysis of Variances (ANOVA) for the statistical significance test of Biomedical data.	
13	Final lab test	
14	Final Quiz + Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C3
	Quiz	30%	CO1, CO2, CO3	C4, C3
	Viva	10%	CO1, CO2, CO3	C4, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

6. Numerical Methods for Engineers by Steven C. Chapra & Raymond P. Canale. 2015 (Seventh Edition), McGraw Hill Education Publications

7. Statistics in MATLABA Primer By MoonJung Cho, Wendy L. Martinez. 2015 (First Edition), CRC Press.
8. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB (Cambridge Texts in Biomedical Engineering) 1st Edition; by Michael R. King and Nipa A. Mody.

REFERENCE SITE

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COURSE INFORMATION

Course Code Course Title	: BME 303 : Biomechanics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

ME 291: Principle of mechanical engineering
PHY 127: Structure of matter, Electricity, Magnetism, and Mechanics

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the major topics/subtopics that include introduction to biomechanics, tissue mechanics, joint biomechanics, movement mechanics, dynamics to human motion, linear and angular kinematics, examples in biomechanics, modern kinematic measurement techniques, applications of human motion analysis, introduction to viscoelasticity.

OBJECTIVE

7. To describe the fundamental of biomechanics.
8. To Study the deformability, strength, viscoelasticity of bone and flexible tissues, modes of loading and failure.
9. To describe the types and mechanics of skeletal joints.
10. To describe movement precisely, using well defined terms (kinematics) and also to consider the role of force in movement (kinetics).
11. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
12. To consider the mechanics of orthopedic implants and joint replacement, artificial heart valve, mechanical properties of cardiovascular and respiratory mechanics

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	To **understand** various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.	C2	1	1	-	1	T, F
CO2	To **analyze** the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.	C4	2	1	-	1, 3	T, F
CO3	To **explain** the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.	C2	1	1	-	1, 3	MID, F

CO4	To **evaluate** the design requirements of medical implants based on human anatomy and biological responses to biomaterials.	C5	4	1	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Kinematic and Kinetic Concepts:
Forms of motion, Standard reference terminology, Joint movement terminology, Force, moment, couples, loads on the human body, Equations of static equilibrium, Structural idealization applications in biomechanics, stress and strain analysis.

Muscle and Movement:
Skeletal muscle morphology, Isotonic versus isometric construction, Muscles constitutive modelling, whole muscle mechanics parallel versus pinnate muscle types, Factors affecting muscular force generation; Muscular strength, power, endurance; muscle and bone interactions.

Basic Statics and Movements at Specific Joints:
Shoulder and Shoulder Girdle; Elbow and Forearm; Wrist and Hand; Trunk and Spine; Hip, Knee, Ankle; Patterns of movement; Structural and Functional Analysis.

Linear and Angular Kinematics of Human Movement:
Overview of linear kinematics, Acceleration, Projectile motion analysis, Linear and angular motion relationship, Modern kinematics measurement techniques.

Linear and Angular Kinetics of Human Movement:
Kinetic law of motion, Angular analogues of Newton's law of motion, Modern kinetics measurement techniques, Application of human motion.

Human Movement in Fluid Medium:
Nature of fluid, Viscoelasticity, Buoyancy, Drag, Lift force, Propulsion in fluid medium.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To **understand** various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.	3											
CO2	To **analyze** the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.		3										
CO3	To **explain** the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.	3											
CO4	To **evaluate** the design requirements of medical implants based on human				3								

	anatomy and biological responses to biomaterials.													

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Kinematic and Kinetic Concepts**	**CT – 1, Final**
Lecture 1	Forces, moments, couples, mechanical loads and effects of loading	
Lecture 2	Forms of motion, Anatomical reference position, planes and axes, Joint movement terminology	
Lecture 3	Equations of static equilibrium and structural idealization applications in biomechanics	
2	**Human Motion Analysis**	
Lecture 4	Modern kinematic measurement techniques	
Lecture 5	Applications of human motion analysis	
Lecture 6	The human gait cycle	
3	**Linear kinematics**	
Lecture 7	Rigid body mechanics	
Lecture 8	Linear kinematics in human motion: measurements and analysis	
Lecture 9	Joint kinematics and Euler's angles	
4	**Angular Kinematics**	

Lecture 10	Angular kinematics relationships, comparison between angular and linear kinematics	**Midterm, Final**
Lecture 11	Angular kinematics of different joints	
Lecture 12	Kinetics in human motion – center of pressure, and ground reaction forces	
5	**Kinetics in human motion**	
Lecture 13	Analysis of ground reaction forces in different axis	
Lecture 14	Forces and moments determination in kinetic studies	
Lecture 15	Determination of joint moments and power	
6	**Musculoskeletal System**	
Lecture 16	Review: stress-strain analysis of materials	
Lecture 17	Introduction to musculoskeletal system- bone anatomy and architecture	
Lecture 18	Mechanical properties of bone, fracture mechanics and healing	
7	**Muscles and Movement**	
Lecture 19	Skeletal muscle morphology and architecture	
Lecture 20	Isotonic versus isometric contraction	
Lecture 21	Muscles constitutive modelling, Whole muscle mechanics parallel versus pinnate muscle types	
Midterm Break		
8	**Introduction to Joints**	**CT – 2, Final**
Lecture 22	Joint – structure and properties	
Lecture 23	Joint – types and movement	
Lecture 24	Structure, movement and loads on the shoulder	
9	**Human Joint Articulation**	
Lecture 25	Joint Architecture, stability and flexibility	
Lecture 26	Common Joint injuries and introduction to the biomechanics of human upper extremity	
Lecture 27	Structure, movement and loads on the shoulder	
10	**Joint Movement Analysis**	
Lecture 28	Structure, movement and loads on the elbow and wrist	
Lecture 29	Structure, movement and loads on the hip, knee and ankle	
Lecture 30	Problem solving	
11	**Joint Movement Analysis of Spine**	**CT – 3, FINAL**
Lecture 31	Stress relaxation properties of articular cartilage	
Lecture 32	Structure, properties and functions of spine	
Lecture 33	Spine mechanics and movement	
12	**Mechanics of tendons, ligaments and articular cartilage**	
Lecture 34	Structure and organization of tendons and ligaments	
Lecture 35	Mechanical and viscoelastic properties of tendons and ligaments	
Lecture 36	Structure, function and mechanical properties of articular cartilage	
13	**Introduction to cell mechanics and mechanobiology**	**FINAL**
Lecture 37	Overview of multi-scale mechanobiology	
Lecture 38	Cell/tissue mechanics – implications in development and disease	
Lecture 39	Cell/tissue mechanics – implications in development and disease	

14	**Review Class**	
Lecture 40	Single cell and bulk tissue mechanical measurements systems	
Lecture 41	Review and Mathematical problem solving	
Lecture 42		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C2, C4, C5
	Class Participation	5%	CO3	C2
	Midterm	15%	CO3	C2
Final Exam		60%	CO 1	C2
			CO 2	C4
			CO 3	C2
			CO 4	C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Susan J. Hall, Basic Biomechanics, McGraw Hill, Sixth Edition.
2. Emico okuno, Luciano Fratin, Biomechanics of the Human Body, Springer.

REFERENCE SITE

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COURSE INFORMATION

Course Code	: BME 304	Lecture Contact Hours	: 3.00
Course Title	: Biomechanics Sessional	Credit Hours	: 1.50

PRE-REQUISITE

Course Code: BME 303

Course Title: Biomechanics

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of experimental analysis and computational techniques to the biomechanics of the human body.

OBJECTIVE

This course aims to introduce students to the generation and analysis of biomechanical models and data.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **analyze** the electromyography signal and mechanics of muscle contraction and joints.	C4	2, 5	-	1	1	T, Q, R
CO2	Be able to **analyze** the linear and angular kinetics and kinematics of a body in motion.	C4	2, 5	-	1	1	T, Q, R
CO3	Be able to **evaluate** the computational model of a body in motion.	C5	2, 5	-	1,3	2	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Introduction to skeletal biomechanics, The study of muscular contraction using electromyography, The study of joint biomechanics, Linear Kinematics of an object in motion and total body center of mass determination, Introduction to linear kinetics and analysis of vertical ground reaction force, Introduction to angular kinematics and range of motion, Creating and simulating the computational model of a dynamic body in motion, Biomedical Orthosis/ Prosthesis design & simulation, Study of Ankle Injury Using OpenSim (Both Free Fall & AFO Assisted), Creating and simulating the computational model of a static and dynamic body in motion

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **analyze** the electromyography signal and mechanics of muscle contraction and joints.		3			3							
CO2	Be able to **analyze** the linear and angular kinetics and kinematics of a body in motion.		3			3							
CO3	Be able to **evaluate** the computational model of a body in motion.		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to skeletal biomechanics	Report, Lab Test, Quiz, Viva
2	The study of muscular contraction using electromyography	
3	Linear Kinematics of an object in motion and total body center of mass determination	
4	Introduction to linear kinetics and analysis of vertical ground reaction force	
5	Introduction to angular kinematics and range of motion	
6	Analysis of kinetics & kinematics data part 1	
7	Analysis of kinetics & kinematics data part 2	
	Midterm Break	
8	Mid Lab Test	Report, Lab Test, Quiz, Viva
9	Biomedical Orthosis/ Prosthesis design & simulation	
10	Study of Ankle Injury Using OpenSim (Both Free Fall & AFO Assisted)	
11	Creating and simulating the computational model of a static body at rest	
12	Creating and simulating the computational model of a dynamic body in motion	
13	Final Lab Test	
14	Quiz and viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (30%)	Report	20%	CO1, CO2, CO3	C4, C5
	Class Participation	10%	CO1, CO2, CO3	C4, C5
Final Exam (70%)	Lab Test	35%	CO1, CO2, CO3	C4, C5
	Quiz	25%	CO1, CO2, CO3	C4, C5
	Viva	10%	CO1, CO2, CO3	C4, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

3. Duane Knudson, Fundamentals of Biomechanics, Second Edition, Springer publication, 2007 (UNIT IV)
4. Donald R. Peterson and Joseph D. Bronzino, Biomechanics Principles and applications, CRC Press, Taylor & Francis Group, LLC, 2008 (UNIT II, III)

REFERENCE SITE

https://simtk-confluence.stanford.edu:8443/display/OpenSim/Building+a+Dynamic+Walker+in+Matlab

COURSE INFORMATION			
Course Code Course Title	: BME 305 : Biomedical Signal Processing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Math 205: Differential Equation, Laplace Transform and Fourier Transform

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to introduce the fundamental concepts and methods for the characterization and analysis of digital signal and systems with a particular emphasis on the understanding of the basic Biomedical signals and systems.

OBJECTIVE

3. To provide the knowledge about the different processing techniques regarding signal and systems
4. To equip students skilled to apply the knowledge of signal processing to solve the real life problems related to Biosignal.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** signals in the time, frequency, Laplace, and Z domains	C2	1	1	-	1,3	T, F
CO2	Be able to **comprehend** the fundamental signal processing techniques	C2	1	1,3	-	1,3	T, F
CO3	Be able to **acquire** popular biomedical signals and their fundamental features'	C2	2	1	-	1	MID, F
CO4	Be able to **design** and **analyze** the basic processing techniques for the Biomedical signals	C3, C4	3	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Signal and System: Linearity of System, Classification and properties of signals, Common signals in engineering, Continuous-Time (CT) and Discrete-Time (DT) signal and system, Quantization, Analog to digital conversion of signal. **Modeling of Signals and Systems:** Impulse Response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) of Discrete-Time Systems, Difference Equation, Convolution, Correlation, Covariance, Transient and Steady-state Response. **Signal Transformation:** Discrete Fourier Transformation (DFT), Fast Fourier Transformation (FFT), Inverse FFT, Z-Transformation, Inverse Z-Transformation. **Randomness and Estimation of Signals:** Linear Time Invariant (LTI) system, Stationarity and Ergodicity, Power Spectral Density, Frequency and Power Spectrum.

Introduction to Biosignals: Origins, properties and suitable models of popular biosignals, Objectives and challenges of Biosignal Analysis; Steps of Biosignal Processing. **Noise** and **Filters:** Noise Models, Averaging filters, Design and principles of Wiener Filter, FIR and IIR filters. **Biomedical Signal Processing:** Spectral analysis of ECG, EEG, EMG, and EOG signals, Case study on ECG and EMG signals, Introduction to Feature Extractions and Classification.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** signals in the time, frequency, Laplace, and Z domains	3											
CO2	Be able to **comprehend** the fundamental signal processing techniques	3											
CO3	Be able to **acquire** popular biomedical signals and their fundamental features'		3										
CO4	Be able to **design** and **analyze** the basic processing techniques for the Biomedical signals			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Signal and System**	**CT – 1, Final**
Lecture 1	Linearity of System, Classification and properties of signals, Common signals in engineering	
Lecture 2	Continuous-Time (CT) and Discrete-Time (DT) signal and system	
Lecture 3	Quantization, Analog to digital conversion of signal	
2	**Modeling of Signals and Systems**	
Lecture 4	Impulse Response	
Lecture 5	Finite Impulse Response (FIR) of Discrete-Time Systems	
Lecture 6	Infinite Impulse Response (IIR) of Discrete-Time Systems	

3	**Modeling of Signals and Systems**	
Lecture 7	Difference Equation	
Lecture 8	Convolution	
Lecture 9	Correlation, Covariance, Transient and Steady-State Response	
4	**Signal Transformation**	**Midterm, Final**
Lecture 10	Discrete Fourier Transformation (DFT)	
Lecture 11	Fast Fourier Transformation (FFT)	
Lecture 12	Fast Fourier Transformation (FFT)	
5	**Signal Transformation**	
Lecture 13	Inverse FFT	
Lecture 14	Z-Transformation	
Lecture 15	Z-Transformation	
6	**Randomness of Biosignals**	
Lecture 16	Z-Transformation	
Lecture 17	Inverse Z-Transformation	
Lecture 18	Inverse Z-Transformation	
7	**Randomness of Biosignals**	
Lecture 19	Linear Time-Invariant (LTI) system, Stationarity and Ergodicity,	
Lecture 20	Frequency and Power Spectrum	
Lecture 21	Frequency and Power Spectrum	
Midterm Break		
8	**Introduction to Biosignals**	**CT – 2, Final**
Lecture 22	Origins, properties and suitable models of popular biosignals	
Lecture 23	Objectives and challenges of Biosignal Analysis	
Lecture 24	Steps of Biosignal Processing	
9	**Noise and Filters**	
Lecture 25	Noise Model	
Lecture 26	Averaging filters	
Lecture 27	Averaging filters	
10	**Time Domain Filters**	
Lecture 28	Design and principles of Wiener Filter	
Lecture 29	Design and principles of Wiener Filter	
Lecture 30	FIR filters	
11	**Digital Filters**	**CT – 3, FINAL**
Lecture 31	FIR filters	
Lecture 32	Fundamental Design of Window-based FIR filter	
Lecture 33	Fundamental Design of Window-based FIR filter	
12	**Digital Filters**	
Lecture 34	IIR Filter design	
Lecture 35	IIR Filter design	
Lecture 36	Applications of IIR Filters in Biosignals	
13	**Biomedical Signal Processing**	**FINAL**
Lecture 37	Spectral analysis of ECG and EEG signals	
Lecture 38	Spectral analysis of EMG and EOG signals	
Lecture 39	Case study on ECG and EMG signals	

14	**Biomedical Signal Processing**
Lecture 40	Case study on ECG and EMG signals
Lecture 41	Introduction to Feature Extractions and Classification
Lecture 42	Introduction to Feature Extractions and Classification

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C3
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. Emmanuel Ifeachor and Barrie Jervis, "Digital Signal Processing: A Practical Approach," Second Edition, Pearson Publications, 2002.
4. S. R. Devasahayam, "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling," Second Edition, Springer Publication, 2013.

REFERENCE BOOKS

1. K J Blinowska and J Zygierewicz, "Practical Biomecial Signal Analysis Using MATLAB," CRC Press, 2012.
2. Robert B. Northrop, Signals and Systems in Biomedical Engineering, CRC Press, 2003

REFERENCE SITE

COURSE INFORMATION

Course Code	: BME 306	Lecture Contact Hours	: 3.00
Course Title	: Biomedical Signal Processing Sessional	Credit Hours	: 1.50

PRE-REQUISITE

BME 305: Biomedical Signal Processing

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to prepare students to apply the knowledge of digital signal processing to apply to Biomedical signals for processing and finding the hidden information inside the Biosignals.

OBJECTIVE

3. To perform different signal processing algorithms and techniques to process the Biomedical signals
4. To apply the knowledge of signals processing techniques for the real-life problems regarding the Biomedical signals

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the signal processing related problems and relevant solution techniques in biomedical signals	C2	2		1	1	T, Q, R
CO2	Be able to **apply** the theoretical knowledge of signal processing and **analyze** the biomedical signals	C3, C4	2, 5		1, 3	1, 2	T, Q, R, ASG
CO3	Be able to **evaluate** the meaningful information from the real-life biomedical signals	C5	2, 5		1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Sampling, quantization, and representation of different Biosignals, Finite and infinite response determination of a signal, Convolution and its application, Correlation and Covariance of signals with its applications, Determination of DFT, FFT, PSD of the Signal, Z-transformation and inverse Z-transformation, Wiener Filter, Window-based FIR filter, IIR filter, Linear transformation.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the signal processing related problems and relevant solution techniques in biomedical signals		3										
CO2	Be able to **apply** the theoretical knowledge of signal processing and **analyze** the biomedical signals		3			3							
CO3	Be able to **evaluate** the meaningful information from the real-life biomedical signals		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introductory Practice on the Fundamentals of Signal Processing in Matlab programming software	Report, Assignment, Lab Test, Viva
2	Experiment on sampling, quantization, and representation of different Biosignals	
3	Experiment on the finite and infinite response determination of a signal	
4	Experiment of Convolution and its application in Biosignal Processing	
5	Investigation on Correlation and Covariance of signals with its applications in Biosignals	
6	Determination of DFT, FFT, PSD of a Biosignal	
7	Experiment on the utilization of Z-transformation and inverse Z-transformation in Biosignal processing	
	Midterm Break	
8	Designing a Wiener Filter to remove noises from Biosignals	Report, Lab Test, Quiz, Viva
9	Designing window-based FIR filter for low pass, high pass, and band-pass filters	
10	Designing IIR filter for low pass, high pass, and band-pass filter	
11	Experiment on the linear transformation of Biosignals	
12	Evaluation of the signal processing-based Project given to the students	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. Emmanuel Ifeachor and Barrie Jervis, "Digital Signal Processing: A Practical Approach," Second Edition, Pearson Publications, 2002.
4. K J Blinowska and J Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB," CRC Press, 2012.

REFERENCE BOOKS

2. S. R. Devasahayam, "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling," Second Edition, Springer Publication, 2013.

REFERENCE SITE

COURSE INFORMATION

Course Code Course Title	: BME 307 : Medical Imaging	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 101: Introduction to Biomedical Engineering

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course designs covering the topics/subtopics that help to learn and familiarize the fundamental methodologies of different medical imaging systems including the modality, imaging physics, image construction algorithms, image intervention, and safety measures during imaging.

OBJECTIVE

3. To acquire the rudimentary knowledge about the medical imaging system and its applicative variances.
4. To provide students with an overview of the computational and mathematical methods in medical imaging.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** different types of medical imaging systems and their applications in clinical diagnosis.	C1	2	1	-	1,3	T, F

CO2	Be able to **understand** the fundamental physics and technologies behind different imaging systems.	C2	1	1,3	-	1,3	T, F
CO3	Be able to **apply** the computational techniques to regulate image construction in digital space.	C3	2	1	-	1	MID, F
CO4	Be able to **investigate** the effect of different algorithms in image computation.	C4	4	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Medical Imaging: Non-invasive medical imaging specialty, Medical imaging modalities with applications, Image Characteristics. **X-Ray:** X-ray generation, x-ray generators, Filters, intensifying screens X-radiography, Spatial resolution, Image noise and Image contrast, Introduction to fluoroscopy, Angiography, and mammography, Digital X-ray, Fundamental of Interventional Radiology. **Computed tomography (CT):** Basics of CT scanner system, Radon Transformation for CT imaging, Image reconstruction algorithms: Fourier slice theorem, Fourier Reconstruction, Back-projection Algorithm, Filtered back-projection method, Iterative reconstruction algorithm; CT number, Image artifacts, and Filtering, Evolution of CT from 1G to 5G. **Nuclear Imaging:** Principles of Gamma Camera, Imaging principles of Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), Brief description of PET and SPECT modalities with differences, Safety measures in nuclear imaging.

Magnetic Resonance Imaging (MRI): Evolution of magnetic resonance imaging (MRI) technology and clinical applications, Fundamentals of nuclear magnetic resonance: Angular momentum, magnetic dipole moment, Magnetization, Larmor frequency, Midterm Break, RF and resonance, free induction decay (FID); Different coils and slice selection, spin-echo pulse sequence; Different modes of MRI Images: T1 and T2 Relaxation images, Gradient echo imaging, Diffusion-weighted imaging, etc.; Biological effects of magnetic fields and MRI imaging safety. **Functional Magnetic Resonance Imaging (fMRI):** Physics behind hemodynamics and NMR, Principle of imaging, Image Features, and Applications. **Ultrasound Imaging:** Principle of imaging, brief description of modality, Doppler effect, Generation and detection of ultrasound-piezoelectric effect; ultrasonic transducers, Focusing arrays, Transducer beam characteristics: Huygens's principle, beam profiles, pulsed ultrasonic field, Axial and lateral resolution, Far-field and near field concept, Modes of Ultrasound Images, Introduction to Doppler imaging.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **remember** the different types of medical imaging systems and their applications in clinical diagnosis.		3										
CO2	Be able to **understand** the fundamental physics and technologies behind the different imaging systems.	3											
CO3	Be able to **apply** the computational techniques to regulate image construction in digital space.		3										
CO4	Be able to **analyze** the effect of different algorithms in image computation.				4								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to Medical Imaging**	**CT – 1, Final**
Lecture 1	Non-invasive medical imaging specialty	
Lecture 2	Medical imaging modalities with applications	
Lecture 3	Image Characteristics	
2	**X-Ray**	
Lecture 4	X-ray generation, x-ray generators,	
Lecture 5	Filters, intensifying screens X-radiography, Spatial resolution,	

Lecture 6	Image noise and Image contrast	
3	**X-Ray**	
Lecture 7	Introduction to fluoroscopy, Angiography, mammography	
Lecture 8	Principles of digital X-ray (CR and DR)	
Lecture 9	Fundamental of Interventional Radiology	
4	**Computed tomography (CT)**	**Midterm, Final**
Lecture 10	Basics of CT scanner system	
Lecture 11	Radon Transformation	
Lecture 12	Radon Transformation	
5	**Computed tomography (CT)**	
Lecture 13	Fourier slice theorem	
Lecture 14	Fourier Reconstruction	
Lecture 15	Back-projection Algorithm and Filtered back-projection method	
6	**Computed tomography (CT)**	
Lecture 16	Iterative methods for Image reconstruction	
Lecture 17	CT number, Image artifacts, and Filtering	
Lecture 18	Evolution of CT from 1G to 5G.	
7	**Nuclear Imaging**	
Lecture 19	Principles of Gamma Camera) and Imaging principles of Positron Emission Tomography (PET)	
Lecture 20	Single Photon Emission Computed Tomography (SPECT)	
Lecture 21	Brief description of PET and SPECT modalities with differences and safety measures	
Midterm Break		
8	**Magnetic Resonance Imaging (MRI)**	**CT – 2, Final**
Lecture 22	Evolution of magnetic resonance imaging (MRI) technology and clinical applications,	
Lecture 23	Fundamentals of nuclear magnetic resonance: Angular momentum, magnetic dipole moment,	
Lecture 24	Fundamentals of nuclear magnetic resonance: Magnetization, Larmor frequency	
9	**Magnetic Resonance Imaging (MRI)**	
Lecture 25	RF and resonance, free induction decay (FID)	
Lecture 26	Different coils and slice selection	
Lecture 27	T1 and T2 Relaxation images	
10	**Magnetic Resonance Imaging (MRI)**	
Lecture 28	Gradient echo imaging	
Lecture 29	Diffusion weighted imaging	
Lecture 30	Biological effects of magnetic fields and MRI imaging safety	
11	**Functional Magnetic Resonance Imaging (fMRI)**	**CT – 3, FINAL**
Lecture 31	Physics behind hemodynamics and NMR	
Lecture 32	Principle of imaging	
Lecture 33	Image Features and Applications.	
12	**Ultrasound Imaging**	
Lecture 34	Principle of imaging, brief description of modality,	

Lecture 35	Doppler effect; Generation and detection of ultrasound-piezoelectric effect;	
Lecture 36	ultrasonic transducers, Focusing arrays	
13	**Ultrasound Imaging**	**FINAL**
Lecture 37	Transducer beam characteristics: Huygens's principle, beam profiles,	
Lecture 38	Pulsed ultrasonic field, Axial and lateral resolution,	
Lecture 39	Far field and near field concept	
14	**Ultrasound Imaging**	
Lecture 40	Introduction to Doppler imaging	
Lecture 41	Diagnosis process of Ultrasound images, applications, safety measures	
Lecture 42	Future trends in Medical imaging	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO1	C2
			CO2	C3
			CO3	C2
			CO4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. J. T. Bushberg, J. A. Seibert, E. M. Leidholdt JR, and J. M. Boone, The Essential Physics of Medical Imaging, Third Edition, LIPPINCOTT WILLIAMS & WILKINS, 2012.
4. P. Dhawan, H. K. Huang, and D. S. Kim, Principles and Advanced Methods in Medical Imaging and Image Analysis, World Scientific Publishing, 2008.

REFERENCE BOOKS

1. Chris Guy and Dominic Ffytche, An Introduction to The Principles of Medical Imaging, Revised Edition, Imperial College Press, 2005.
2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, Medical Physics and Biomedical Engineering, Medical Science Series, 1999.

REFERENCE SITE

COURSE INFORMATION

Course Code	: BME 309	Lecture Contact Hours	: 3.00
Course Title	:Biomedical Transport Phenomenon	Credit Hours	: 3.00

PRE-REQUISITE

Course Code: BME 203

Course Title: Biofluid Mechanics and Heat Transfer

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the topics that include mass, momentum and heat transport, Basic hemodynamic, equations of continuity and motion, molecular mechanics of fluid and electrolyte transport, Shear stress, mass transfer and metabolism in organs and tissues, compartmental models for pharmacokinetic analyses, analysis of blood oxygenators, Unsteady-state heat transfer modes and laws, heat transfer coefficient, heat transfer inside the body, heat transfer between body and surrounding; Analogy equations relating momentum, energy and mass transfer.

OBJECTIVE

3. This course aims to develop students' basic engineering knowledge of momentum, mass, and heat transfer in integrated form through an array of examples and analysis from biological systems (cellular, tissue, organ levels) and from the design of medical devices.
4. Application of these principles, using quantitative methods based on fundamental physical laws, to solve problems in biology, of clinical significance, and problems in the design and development of medical devices, implants, including tissue-engineered constructs.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	To **apply** mathematics, science, and engineering principles, methodologies to formulate and solve problems at the interface of engineering and biology, physiology, including processes leading to disease states.	C3	2	1	-	1,3	T, F
CO2	To **interpret** results from formulated engineering problems derived for living systems as well as the ability to infer and to make refinement for further insights at the interaction between living and non-living materials and systems.	C4	2	1,3	-	1,3	T, F
CO3	To **evaluate** the breadth and depth across the range of engineering topics and their applications in biological, physiological problems including	C5	4	1	-	1	MID, F

	medical devices that enhance the quality of healthcare delivery.						

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to mass, momentum and heat transport in living systems; Basic hemodynamic; Use of the equations of continuity and motion to set up complex flow problems; Basic molecular mechanics of fluid and electrolyte transport across cell membranes and epithelia; Flow within distensible tubes; Shear stress and endothelial cell function; Mass transfer and metabolism in organs and tissues; Microscopic and macroscopic mass balances; Diffusion: mass transfer between fluids, membrane and pores; mass transfer coefficient; Blood-tissue transport of solutes in the microcirculation; Mass transfer in kidney dialysis; Compartmental models for pharmacokinetic analyses; Analysis of blood oxygenators; Unsteady-state heat transfer modes and laws, heat transfer coefficient, heat transfer inside the body, heat transfer between body and surrounding; Analogy equations relating momentum, energy and mass transfer.

Introduction to mass and momentum in living systems; Basic hemodynamic; Application of momentum balance; Rheology and blood flow; Conservation relation for fluid transport, dimensional analysis and scaling; Methods for analysing complex physiological flow; Flow in circulatory system and tissue; Flow within distensible tubes; Shear stress and endothelial cell function; Heart-valve hemodynamics; Mass transfer and metabolism in organs and tissues; Diffusion: mass transfer between fluids, membrane and pores; Diffusion with convection or electrical potential; Microscopic and macroscopic mass balances; Transport in porous media; Transvascular transport; Transport of gases between blood and tissue; Analysis of blood oxygenators; Fluid transport in the kidneys; A whole organ approach to renal modelling; Drug transport in solid tumors; Transport in organs and organisms; Compartmental models for pharmacokinetic analyses.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To **apply** mathematics, science, and engineering principles, methodologies to formulate and to solve problems at the interface of engineering and biology, physiology, including processes leading to disease states.		3										
CO2	To **interpret** results from formulated engineering problems derived for living systems as well as the ability to infer and to make refinement for further insights at the interaction between living and non-living materials and systems.		3										

CO3	To **evaluate** the breadth and depth across the range of engineering topics and their applications in biological, physiological problems including medical devices that enhance the quality of healthcare delivery.				3								

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to transport fundamentals**	**CT – 1, Final**
Lecture 1	Overview of the transport process and cellular transport	
Lecture 2	Application of transport process in disease pathology	
Lecture 3	An overview of hemodynamics and boundary conditions	
2	**Dimensionless numbers**	
Lecture 4	The Buckingham Pi Theorem and dimensionless numbers	
Lecture 5	Dimensionless numbers in biofluid dynamics	
Lecture 6	Equation of conservation of mass and linear momentum	
3	**Conservation of mass and momentum**	
Lecture 7	Differential continuity equation in rectangular co-ordinates	
Lecture 8	Momentum balance and forces in fluids	

Lecture 9	Euler's, Bernoulli's, and the general form of the Navier-Stokes equation	
4	**Dynamic similarity and introduction to pulsatile flow**	**Midterm, Final**
Lecture 10	Relationship between Navier Stokes and Hagen–Poiseuille equation	
Lecture 11	Dynamic similarity and non-dimensionalizing the Navier-Stokes equation	
Lecture 12	Introduction to oscillating flow in blood vessels	
5	**Pulsatile flow**	
Lecture 13	Velocity profile in pulsatile flow	
Lecture 14	Velocity profile in pulsatile flow	
Lecture 15	Volumetric flow rate in pulsatile flow	
6	**Pulsatile flow continued**	
Lecture 16	Velocity-pressure phase lag in pulsatile flow	
Lecture 17	Womersley number and entrance length in physiological flows	
Lecture 18	Introduction to flow in curved vessels, Dean number and secondary flows	
7	**Flow in curved vessels**	
Lecture 19	Flow separation, adverse pressure gradient, and flow in branching vessels	
Lecture 20	Blood flow and velocity profiles in major arteries	
Lecture 21	Modeling and visualizing blood flow	
Midterm Break		
8	**Transport in Porous Media**	**CT – 2, Final**
Lecture 22	Porosity, Tortuosity, and Volume fraction	
Lecture 23	Fluid flow in porous media	
Lecture 24	Solute transport in porous media	
9	**Mass Transport in Biological System**	
Lecture 25	Conservation and constitutive relation	
Lecture 26	Diffusion, Diffusion coefficient, Steady-state and unsteady diffusion	
Lecture 27	Diffusion-limited reaction	
10	**Diffusion with Convection or Electrical Potential**	
Lecture 28	Fick's law, Dimensional analysis, Electrolyte transport	
Lecture 29	Diffusion and convection, mass transfer coefficients	
Lecture 30	Microscopic and macroscopic mass balances across membranes	
11	**Transport of Gases between Blood and Tissue**	**CT – 3, FINAL**
Lecture 31	Oxygen-Hemoglobin equilibria	
Lecture 32	Dynamics of oxygenation of blood and oxygen delivery in tissue Nitric oxide production and transport in tissue	

Lecture 33	Whole-organ approach to renal modeling	
12	**Drug Transport in Solid Tumors**	
Lecture 34	Introduction to drug delivery in cancer treatment	
Lecture 35	Analysis of transvascular and interstitial fluid transport	
Lecture 36	Interstitial hypertension in solid tumor	
13	**Drug Transport in Solid Tumors, and Pharmacokinetics**	**FINAL**
Lecture 37	Analysis of interstitial transport of solutes	
Lecture 38	Consideration in Pharmacokinetics	
Lecture 39	Compartment models in pharmacokinetic analysis	
14	**Transport in Organs and Organisms**	
Lecture 40	Physiologically based pharmacokinetic models	
Lecture 41	Review	
Lecture 42	Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1.Truskey, Yuan, and Katz, Transport Phenomena in Biological Systems, Second Edition, Pearson Education, Inc.
2.Johnson and Ethier, Problems in Biomedical Fluid Mechanics and Transport Phenomena, Cambridge University Press.

REFERENCE SITE

https://classroom.google.com/u/0/c/NDQzMzQ1NDQzNjla

COURSE INFORMATION			
Course Code Course Title	: BME 311 : Embedded Systems and Interfacing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: CSE 291
Course Title: Computer Programming
Course Code: CSE 292
Course Title: Computer Programming Lab
Course Code: EECE 391
Course Title: Digital Electronics
Course Code: EECE 392
Course Title: Digital Electronics Lab

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to expose students to the field of embedded systems and to provide a knowledge foundation which will enable students to pursue a career in relevant fields. Key concepts of hardware-software interfacing control architectures, debugging, and communication protocols will be discussed in this course. Students will be familiar with different firmware architectures and can apply their knowledge in relevant fields such as; clinical device development and robotics in healthcare.

OBJECTIVE

5. To identify and understand fundamentals of microprocessors, microcontrollers, communication protocols and embedded firmware.
6. To apply the fundamental concepts of embedded engineering
7. To analyze the various firmware architectures and systems
8. To evaluate various large scale embedded systems

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** and **understand** the fundamentals of microprocessors, microcontrollers, communication protocols and embedded firmware.	C1, C2	1,2	1	-	3	T, F
CO2	Be able to **apply** the fundamental concepts of embedded engineering.	C3	2	1,3	-	3	T, F
CO3	Be able to **analyze** the various firmware architectures and systems.	C4	2	1	-	5	MID, F
CO4	Be able to **evaluate** various large scale embedded systems	C5	4	1,3	-	5	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Embedded System : Introduction to Embedded Engineering, Chronological development of Firmware and Embedded Technology, Possible Implementation in Healthcare, Review on Digital Techniques : Bit and Bytes, Memory, Number systems, Additions, Subtractions, Multiplications, Boolean Algebra, Divisions, Logic Gates, Combinational Circuits, Decoders, Encoders, Bit and Bytes, Memory, Number systems, Additions, Subtractions, Multiplications, Boolean Algebra, Divisions. **Microprocessors and Microcontrollers:** Flags, Resistors, Processor Types, Processor Architecture, Instruction Sets, Addressing Modes, SAP, 8086 Microprocessors, Memory, Memory Architecture, Virtual Memory, DMA and DMA Controller, AVR and ARM controllers, Overview of Developmental Microcontroller and Microprocessors, Thread, Interrupts, Programmable Timers, Multitasking, Workflow and Architecture of 16 bit/32bit PIC **Firmware Programming:** Assembly Language: Basic Assembly, Bit Operators, Sub Programs, Switch Day, Arrays, Strcuts, Instruction sets, Loops, Conditional Statements. (Higher Level Language; Python: Data Types, python Data Structure, Functions, Object Oriented Programming, Encapsulation, Abstraction, Inheritance, Polymorphism Or C++/objective C: Data Types, Data Structure, Struc, Encapsulation, Abstraction), Inheritance Firmware Architecture, Reset Circuit, Watchdog Timer. **Advanced Systems:** Operating Systems, Real Time OS, Virtual Machine, FPGA, Clustering, Master Slave Topology, Multithread Processors, IoT Architecture, Medical robotics

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** and **understand** the fundamentals of microprocessors, microcontrollers, communication protocols and embedded firmware.	3	3										
CO2	Be able to **apply** the fundamental concepts of embedded engineering.		3										
CO3	Be able to **analyze** the various firmware architectures and systems.		3										
CO4	Be able to **evaluate** various large scale embedded systems				4								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE		
Week	**Topic**	**Assessment**
1	**Motivation and course introduction**	**CT – 1, Final**
Lecture 1	Introduction to Embedded Engineering, Chronological development of Firmware and Embedded Technology, Importance of Embedded Engineering in Healthcare	
Lecture 2	Review of Bit and Bytes, Subtractions, Multiplications, Division, Boolean Algebra	
Lecture 3	Review of Logic Gates, Combinational Circuits, Decoders, Encoders	
2	**Introduction to microprocessors**	
Lecture 4	Microprocessor Fundamentals, Types of Processors	
Lecture 5	Processor architecture	
Lecture 6	Simple As Possible (SAP) Architecture	
3	**Microprocessor Fundamentals**	
Lecture 7	Overview of 8086 Microprocessor	
Lecture 8	8086 Microprocessor Instruction sets	
Lecture 9	8086 Microprocessor Addressing Modes	
4	**Basic Embedded Firmware**	**Midterm, Final**
Lecture 10	Assembly Language – 1	
Lecture 11	Assembly Language – 2	
Lecture 12	Assembly Language – 3	
5	**Higher Level Embedded Firmware**	
Lecture 13	Introduction to Data Types, Variable, Operators, If-else, Lists, Functions and basic syntax	
Lecture 14	Object-Oriented Programming	
Lecture 15	Object-Oriented Programming	
6	**Communication Protocols**	
Lecture 16	Intro to Computer Networking and Networking Layers, Bus Interface, I/O Hardware and Interface, Peripheral Interfacing,	
Lecture 17	Wired Communication Protocols (USB, UART, I2C, SPI, CAN)	
Lecture 18	Wireless Communication Protocols (Bluetooth, GSM, ZigBEE, BLE and others)	
7	**Sensors, Actuators and Interfacing**	
Lecture 19	Introduction to Sensors and Actuators, Fundamentals of Sensors and Different Types of Sensors	
Lecture 20	Fundamentals of Actuators and Different Types of Actuators, Interfacing of Sensors and Actuators	
Lecture 21	Interfacing of Sensors and Actuators (Continued)	
Midterm Break		
8	**Overview of Memory**	
Lecture 22	Introduction to Memory, Memory Architecture	
Lecture 23	Memory Hierarchy, Memory Interface	

Lecture 24	Virtual Memory, DMA (Direct Memory Access) and DMA Controller	**CT – 2, Final**
9	**Threads, Interrupts, Timer and Multitasking**	
Lecture 25	Basic Concepts and Applications of Threads, Overview of Interrupts	
Lecture 26	Introduction to Programmable Timer fundamentals, Fundamental Concepts of Programmable Interrupt Controller,	
Lecture 27	Overview of Multitasking in Microprocessors and Embedded Systems	
10	**Microcontrollers Basics, Microcontroller Architectures and Application**	
Lecture 28	AVR and ARM Microcontrollers	
Lecture 29	Overview PIC Microcontroller	
Lecture 30	Overview PIC Microcontroller (continued)	
11	**Advance Firmware Architecture and Advance Concepts in Embedded Engineering**	**CT – 3, FINAL**
Lecture 31	Reset Circuit , Watchdog Timer, Reliable Architecture in Firmware and system design approaches	
Lecture 32	Reliable Architecture in Firmware and system design approaches (continued)	
Lecture 33	Operating Systems Basics, RTOS, Virtual Machines	
12	**FPGA Boards**	
Lecture 34	Introduction to FPGA Boards	
Lecture 35	Fundamentals of FPGA Boards	
Lecture 36	Applications of FPGA Boards	
13	**Distributed Systems, Artificial Intelligence and IoT Architecture in Embedded Systems**	**FINAL**
Lecture 37	Clustering, Master-Slave Topology, Multithread Processors	
Lecture 38	IoT Architecture and Web Assembly	
Lecture 39	AI Algorithms in microcontrollers and microprocessors	
14	**Embedded Systems in Healthcare, R&D work process and Production Line Designing**	
Lecture 40	Current Trends in Embedded Systems in Healthcare	
Lecture 41	Overview of Robotics in Healthcare, Advanced Surgical Procedures and Medical Device Development	
Lecture 42	R&D work Process and Production Line Designing	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1,C2,C3
	Class Participation	5%	CO1	C1,C2
	Midterm	15%	CO1,CO2	C1,C2,C3
Final Exam		60%	CO 1	CO 1
			CO 2	CO 2
			CO 3	CO 3
			CO 4	CO 4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. Onatham W. Valvano, Brookes/Colem Embedded Mircrocomputer Systems: Real Time Interfacing, Pacific Grove: 2000
4. Charles Marut and Ytha Y. YuAssembly Language Programming and Organization of the IBM PC: McGraw-Hill, 1992. ISBN: 0071128964, 9780071128964

REFERENCE BOOKS

3. Douglas V Hall, Microprocessors and Interfacing
4. Mohamed Rafiquzzaman, Microprocessors and Microcomputer-based System Design, CRC Press, 1995

REFERENCE SITE

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COURSE INFORMATION

Course Code Course Title	: BME 312 : Embedded Systems and Interfacing Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 311
Course Title: Embedded Systems and Interfacing
Course Code: CSE 291
Course Title: Computer Programming
Course Code: CSE 292
Course Title: Computer Programming Lab
Course Code: EECE 391
Course Title: Digital Electronics
Course Code: EECE 392
Course Title: Digital Electronics Lab

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of embedded engineering in the domain of biomedical device development and interfacing.

OBJECTIVE

This course aims to enhance students' knowledge on the basic principles of fluid mechanics and heat transfer design problem solution.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** the fundamental concepts of embedded engineering.	C3	2	-	1,3	3	T, Q, R
CO2	Be able to **analyze** the various firmware architectures and systems.	C4	2	-	1	5	T, Q, R, ASG
CO3	Be able to **evaluate** various large scale embedded systems	C5	4	-	1,3	5	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Boolean functions and logic gates, interfacing digital lighting display with microprocessor, stepper motor control with 8086 microprocessor, introduction to developmental boards, stepper motor control with developmental boards, introduction to single board computers, capturing video feedback with single board computers, USB communication, Bluetooth communication, biosignal acquisition with developmental boards and single board computers, implementation of threads, programmable timers, clusters, introduction and overview of 16bit PIC microcontroller, PCB designing.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** the fundamental concepts of embedded engineering.		3										
CO2	Be able to **analyze** the various firmware architectures and systems.		3										
CO3	Be able to **evaluate** various large scale embedded systems				3								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	

Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Implementation of Boolean functions using logic gates	Report, Assignment, Lab Test, Quiz, Viva
2	Interfacing digital lighting display (Dot-matrix) with microprocessor	
3	Stepper Motor Control With 8086 Microprocessor	
4	Introduction to Arduino Development Board and Stepper Motor Control with Arduino Uno	
5	Introduction to Raspberry Pi and Video Feed Capture with Raspberry Pi	
6	USB Communication Between Arduino and Raspberry Pi and Interfacing with Temperature Sensor	
7	PCB Designing in Proteus, Discussion on Project Proposal	
Midterm Break		
8	Introduction To IoT: Bluetooth Communication and Storing of Data with Raspberry Pi and Arduino	Report, Lab Test, Quiz, Viva
9	Biosignal Acquisition and Display with Arduino and Raspberry Pi Cluster	
10	Implementation of Threads, Programmable Timer with Raspberry Pi-Arduino Cluster and LEDs	
11	Introduction to 16bit PIC Microcontroller and LED Switching with 16 bit PIC Microcontroller	
12	Project Presentation	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C3, C4, C5
	Class Participation	20%	CO1, CO2, CO3	C3, C4, C5
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C3, C4, C5
	Quiz	30%	CO1, CO2, CO3	C3, C4, C5
	Viva	10%	CO1, CO2, CO3	C3, C4, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS
1.Onatham W. Valvano, Brookes/Colem Embedded Mircrocomputer Systems: Real Time Interfacing, Pacific Grove: 2000 2.Charles Marut and Ytha Y. YuAssembly Language Programming and Organization of the IBM PC: McGraw-Hill, 1992. ISBN: 0071128964, 9780071128964
REFERENCE BOOKS
1.Douglas V Hall, Microprocessors and Interfacing 2.Mohamed Rafiquzzaman, Microprocessors and Microcomputer-based System Design, CRC Press, 1995
REFERENCE SITE
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COURSE INFORMATION			
Course Code Course Title	: BME 313 : Biomedical Image Processing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 305: Biomedical Signal Processing
BME 307: Medical Imaging

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to prepare students to learn the basic knowledge regarding the processing techniques of medical images including filtering, transformation, compression, storage, reconstruction, segmentation, etc. to enhance its quality so that the medical image-based diagnosis process could be aided.

OBJECTIVE

3. To provide knowledge about the different processing techniques regarding medical images.
4. To equip students theoretically skilled in medical image processing to solve the real-life problem related to imaging-based clinical diagnosis.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** different steps of biomedical image processing steps and their applications in clinical diagnosis.	C1	1	1	-	1,3	T, F
CO2	Be able to **understand** the fundamental image processing technique.	C2	1	1,3	-	1,3	T, F
CO3	Be able to **apply** the basic image processing techniques with a modified form to medical images.	C3	5	1	-	1	MID, F
CO4	Be able to **analyze** the medical image related to real-life problems and possible processing techniques for aiding diagnosis.	C4	2	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Origin of Medical Images and Processing: Medical image sources, Properties, Processing challenges, Processing steps, Image representation, Hardware, and software requirements. **Image as Two-dimensional (2D) systems:** Image as a 2D signal, 2D sequences, and systems, Vector-space image representation, superposition and convolution, 2D Sampling theory, Image quantization, Image perception, Smoothing & Sharpening, Spatial filtering, Quality measures. **Image Transforms:** 2D Fourier Transform, Sine and Cosine transformation, Hadamard transformation, Slant, and KL transformation. **Colors in Image:** Concept of monochrome and color images, Color Fundamentals, Color Models, Pseudo Color Image Processing, Basics of Full-Color Image Processing, Color Transformations.
Image Enhancement: Image Enhancement in spatial domain: Gray Level Transformations, Histogram Processing, Smoothing and Sharpening Spatial Filters; Image Enhancement in the frequency domain: Smoothing Frequency-

Domain Filters, Sharpening Frequency Domain Filters. **Image Reconstruction:** Reconstruction concept of medical images, Image reconstruction in X-Ray, Image reconstruction in CT, Fourier slice theorem, Back projection algorithm for parallel projection data, Filtered-back projection algorithm, Image Reconstruction in Magnetic Resonance Imaging, Image Reconstruction in Ultrasound Imaging. **Image segmentation:** Feature Extraction, Edge Detection, Boundary Extraction, Region Representation, Moment Representation, Shape Features, Scene Matching Image Segmentation, Threshold-based segmentation, Region growing segmentation, Active contour model for segmentation.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to**understand** different steps of biomedical image processing steps and their applications in clinical diagnosis.	3											
CO2	Be able to **understand** the fundamental image processing technique.	3											
CO3	Be able to **apply** the basic image processing techniques with the modified form to medical images.					3							
CO4	Be able to **analyze** the medical image related to real-life problems and possible processing techniques for aiding diagnosis.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Origin of Medical Images and Processing**	
Lecture 1	Medical image sources, Properties	
Lecture 2	Processing challenges, Processing steps	
Lecture 3	Image representation, hardware and software requirements	
2	**Image as Two-dimensional (2D) systems**	

Lecture 4	Image as a 2D signal, 2D sequences, and systems	**CT – 1, Final**
Lecture 5	Vector-space image representation	
Lecture 6	superposition and convolution	
3	**Image as Two-dimensional (2D) systems**	
Lecture 7	2D Sampling theory, Image quantization, Image perception	
Lecture 8	Smoothing & Sharpening, Quality measures	
Lecture 9	Spatial filtering	
4	**Image Transforms**	**Midterm, Final**
Lecture 10	2D Fourier Transform	
Lecture 11	Sine transformation	
Lecture 12	Cosine transformation	
5	**Bio-image compression algorithms**	
Lecture 13	Hadamard Transformation	
Lecture 14	Slant Transform	
Lecture 15	KL Transform	
6	**Colors in Image**	
Lecture 16	Concept of monochrome and color images	
Lecture 17	Color Fundamentals	
Lecture 18	Color Models	
7	**Colors in Image**	
Lecture 19	Pseudo Color Image Processing	
Lecture 20	Basics of Full-Color Image Processing	
Lecture 21	Color Transformations	
Midterm Break		
8	**Image Enhancement (Spatial Domain)**	**CT – 2, Final**
Lecture 22	Gray Level Transformations, Histogram Processing	
Lecture 23	Smoothing Spatial Filters	
Lecture 24	Sharpening Spatial Filters	
9	**Image Enhancement (Frequency Domain)**	
Lecture 25	Smoothing Frequency-Domain Filters	
Lecture 26	Smoothing Frequency-Domain Filters	
Lecture 27	Sharpening Frequency Domain Filters	
10	**Image Reconstruction**	
Lecture 28	Reconstruction concept of medical images	
Lecture 29	Image reconstruction in X-Ray	
Lecture 30	Image reconstruction in CT	
11	**Image Reconstruction**	**CT – 3, FINAL**
Lecture 31	Fourier slice theorem	
Lecture 32	Back projection algorithm for parallel projection data	
Lecture 33	Filtered-back projection algorithm	
12	**Image Reconstruction**	
Lecture 34	Image Reconstruction in Magnetic Resonance Imaging	
Lecture 35	Image Reconstruction in Ultrasound Imaging	
Lecture 36	Feature Extraction	
13	**Image segmentation**	**FINAL**
Lecture 37	Edge Detection, Boundary Extraction	

Lecture 38	Region Representation, Moment Representation	
Lecture 39	Shape Features, Threshold-based segmentation	
14	**Image segmentation**	
Lecture 40	Scene Matching Image Segmentation	
Lecture 41	Region growing segmentation,	
Lecture 42	Active contour model for segmentation	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO1	C2
			CO2	C3
			CO3	C2
			CO4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson, 2017.
4. Atam P. Dhawan, Medical Image Analysis, Second Edition, IEEE Series in Biomedical Engineering, 2011.

REFERENCE BOOKS

1. Jiri Jan, Medical Image Processing, Reconstruction and Restoration: Concept and Method, Taylor and Francis Publisher, 2006.

REFERENCE SITE

COURSE INFORMATION

Course Code Course Title	: BME 314 : Sessional on Biomedical Image Processing	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

BME 307: Medical Imaging

BME 313: Biomedical Image Processing

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to furnish students' knowledge of Medical Imaging and Biomedical Image Processing including quality assurance, quality control, calibration, and maintenance of medical imaging devices, as well as the reconstruction and processing of medical images.

OBJECTIVE

3. To perform the quality assurance, quality control, calibration, and maintenance of medical imaging modalities
4. To process the problems regarding the medical image reconstruction and quality enhancement

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the procedure of quality assurance quality control, calibration and maintenance of medical imaging modalities practically.	C2	1	-	1	1	T, Q, R
CO2	Be able to **apply** and **analyze** the construction and processing mechanism of the medical images.	C3, C4	2	-	1, 3	1, 2	T, Q, R, ASG
CO3	Be able to **apply** different algorithms to the medical images to solve imaging-based diagnosis	C2	5	-	1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Medical Imaging, their modalities, and the relevance to Biomedical Engineering, Observation the imaging techniques of different medical imaging modalities and learning about quality control system as per guideline of IAE and NCRT, Fundamental image processing techniques by MATLAB, Processing techniques of an X-ray Image, Radon transformation and Sinogram for the CT Imaging, Back projection algorithm to reconstruct CT image, Image Segmentation, Case study on medical images to improve the image quality for aiding diagnosis.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the procedure of quality assurance quality control, calibration, and maintenance of medical imaging modalities practically.	3											
CO2	Be able to **apply** and **analyze** the construction and processing mechanism of the medical images.		3										
CO3	Be able to **apply** different algorithms to the medical images to solve imaging-based diagnosis					3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to Medical Imaging, their modalities, and the relevance to Biomedical Engineering	Report, Assignment, Lab Test, Viva
2	A study tour to a medical imaging center to observe the imaging techniques of X-ray and CT and learning about quality control system as per guideline of IAE and NCRT.	

3	A study tour to a medical imaging center to observe the techniques of MRI and Ultrasound imaging and learning about quality control system as per guideline of IAE and NCRT.	
4	A study tour to a medical imaging center to observe the techniques of Nuclear Imaging and learning about quality control system as per guideline of IAE and NCRT.	
5	Introductory practice on the fundamental image processing techniques by MATLAB	
6	Experiment on the processing techniques of an X-ray Image	
7	Experiment on the Radon transformation and Sinogram for the CT Imaging	
	Midterm Break	
8	Design and implementation of the back-projection algorithm to reconstruct CT image	Report, Lab Test, Quiz, Viva
9	Experiment on the segmentation of the brain MRI images	
10	Case study on image processing to improve the image quality for aiding diagnosis.	
11	Case study on image processing to improve the image quality for aiding diagnosis.	
12	A project show based on medical image processing by the students	
13	Final Lab Test	
14	Quiz/Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1.Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson, 2017.
2.Atam P. Dhawan, Medical Image Analysis, Second Edition, IEEE Series in Biomedical Engineering, 2011.

REFERENCE BOOKS

1.Jiri Jan, Medical Image Processing, Reconstruction and Restoration: Concept and Method, Taylor and Francis Publisher, 2006.

REFERENCE SITE

COURSE INFORMATION

Course Code Course Title	: BME 315 : Biomaterials	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

CHEM 103 – **General Chemistry**; CHEM 125 – Physical and Bio-organic Chemistry; BME 203– Biochemistry

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers the following modules: Structure of solids, characterization of biomaterials, metallic implant materials, ceramic implant materials, synthetic polymeric materials, composite biomaterials and material-tissue interactions, sterilization of biomaterials, structure and function of natural biomaterials.

OBJECTIVE

3. To introduce students to different implants, prosthetic and functional materials, investigate the materials' properties including their designs and applications.
4. To investigate both synthetic and natural polymers, and explore biomaterial-tissue interaction in detail with a focus on applications in tissue engineering and cardiology.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to identify different types of biomaterials	C2	2	-	-	1	T, MID
CO2	Be able to **understand** and **analyze** the properties of biomaterials	C2	1	-	-	1	T, MID, F
CO3	Be able to **comprehend** the interactions of cell and tissues with biomaterials based on biomaterial properties and reactivity	C5	4,2	-	3	1	MID, F
CO4	Be able to **design** and **apply** different types of biomaterials to solve biomedical problems	C3	3	-	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The structure of solid: Structure of solids overview, classification of solids, classification of solids based on structure, lattice imperfections and defects

Properties and Characterization of Materials: Thermal properties phase diagrams, strengthening by heat treatments, surface properties and adhesion. Electrical properties, optical properties, x-ray absorption, acoustic and ultrasonic properties, density and porosity and diffusion properties, XPS, XRD, spectroscopy, SFM, AFM, optical characterization of biomaterials

Metallic Biomaterials: Stainless steels, co-based alloys, Ti and Ti-based alloys, dental metals, other metals, corrosion of metallic implants.

Ceramic Implant Materials: Structural property relationship of ceramics, aluminum oxides (alumina), zirconium oxides (zirconia), calcium phosphate, glass ceramics, other ceramics, carbons, deterioration of ceramics.

Synthetic Polymeric Material: Basic structure, classifications (thermoplasts, thermoset, and elastomers), different physical and mechanical properties, and various uses of biomaterials. Natural polymeric materials, biodegradable polymers, applications and functions

Composites as Biomaterials: Structure, mechanics of composites, applications of composite biomaterials, biocompatibility of composite, biomaterials.

Biological response to biomaterials: biocompatibility, toxicity of biomaterials, host response of biological materials to biomaterials, sterilization of biomaterials, applications of biomaterials in cardiology and tissue engineering

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to identify different types of biomaterials		3										
CO2	Be able to **understand** and **analyze** the properties of biomaterials	3											
CO3	Be able to **investigate** the interactions of cell and tissues with biomaterials based on biomaterial properties and reactivity		3		3								
CO4	Be able to **design** and **apply** different types of biomaterials to solve biomedical problems			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Course Introduction and the structure of solids**	
Lecture 1	Motivation & introduction to biomaterials	
Lecture 2	Overview of classification of Solids	
Lecture 3	Overview of structure of solids	

2	**Structure solids**	**CT – 1 and Midterm, Final**
Lecture 4	Classification of solids according to structure	
Lecture 5	Lattice imperfections and defects	
Lecture 6	Mechanical testing methods, tensile and compression properties of biomaterials	
3	**Mechanical properties and characterization of biomaterials**	
Lecture 7	Shear properties, stress-strain properties and analysis of biomaterials	
Lecture 8	Bending properties, time independent properties, creep and fatigue of biomaterials	
Lecture 9	Phase Diagrams 1	
4	**Thermal processing and properties of biomaterials**	**Midterm, Final**
Lecture 10	Phase Diagrams 2	
Lecture 11	Thermal properties and heat treatment of biomaterials	
Lecture 12	Surface properties and adhesion	
5	**Physical Properties of Biomaterials**	
Lecture 13	Electrical and optical properties of biomaterials	
Lecture 14	X-ray diffraction, ultrasonic properties, density, porosity and diffusion properties	
Lecture 15	X-ray diffraction, Bragg's Law, crystal structure determination	
6	**Characterization of biomaterials**	
Lecture 16	XPS, spectroscopy techniques	
Lecture 17	AFM, SFM, SEM, and optical techniques	
Lecture 18	Different types of metallic biomaterials - stainless steel, Co-Cr alloy, Titanium, dental implants	
7	**Metallic biomaterials**	
Lecture 19	Different types of metallic biomaterials - stainless steel, Co-Cr alloy, Titanium, dental implants	
Lecture 20	Properties, fabrication and corrosion of metallic implants	
Lecture 21	Revision	
MIDTERM		
8	**Ceramic Biomaterials**	**CT – 2, FINAL**
Lecture22	Structural Property relationship of ceramics	
Lecture 23	Properties and functions of alumina, zirconia, calcium phosphate	
Lecture 24	Glass ceramics, other ceramics, degradation of ceramics	
9	**Polymeric biomaterials**	
Lecture 25	Structure, classification, properties and processing of polymeric materials	
Lecture 26	Structure, classification, properties and processing of polymeric materials	
Lecture 27	Natural polymeric materials – function and properties	
10	**Polymeric biomaterials**	
Lecture 28	Hydrogel – properties, functions and applications	
Lecture 29	Biodegradable polymers – properties, functions and applications	
Lecture 30	Polymeric biomaterials in biosensor applications	
11	**Composite Biomaterials and Biocompatibility**	
Lecture 31	Structure of composite biomaterials	
Lecture 32	Composite biomaterials – functions, properties, and applications	

Lecture 33	Biocompatibility and toxicity of biomaterials	
12	**Biomaterial interactions with proteins/tissues**	**CT – 3, FINAL**
Lecture 34	Protein-biomaterial interactions	
Lecture 35	Cell/tissue-biomaterial interactions	
Lecture 36	Cell/tissue-biomaterial interactions	
13	**Biological response to biomaterials**	
Lecture 37	Host response (biological response) to biomaterials	
Lecture 38	Toxicity and immune response	
Lecture 39	Sterilization methods and handling of biomaterials	
14	**Applications of biomaterials**	
Lecture 40	Tissue engineering scaffolds and stem cell engineering	
Lecture 41	Cardiac applications of biomaterials	
Lecture 42	Revision	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2
	Class Participation	5%	CO2	C4
	Midterm	15%	CO1, CO2	C2, C4
Final Exam		60%	CO 1	C2
			CO 2	C4
			CO 3	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

3. Biomaterials, Joyce Y Wong, Joseph D Bronzino, CRC Press (latest edition)
4. Mechanics of Biomaterials: Fundamental Principles for Implant Design (1st edition), Lisa A Pruitt, Ayyana M. Chakravartula, Cambridge University Press

REFERENCE BOOKS

2. Materials Science and Engineering - An Introduction, 4th Ed,WD Callister, Jr.

REFERENCE SITE

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COURSE INFORMATION

Course Code Course Title	: BME 316 : Biomaterials Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 315

Course Title: Biomaterials

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the characterization of mechanical, physical, and chemical properties, such as young's modulus, ductility, porosity, corrosion, and surface topography of biomaterials.

OBJECTIVE

This course aims to introduce students to biomaterial testing and the factors influencing their functions.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to investigate different biomaterials to determine their mechanical properties.	C4	4		1	1, 2	T, Q, R
CO2	Be able to investigate different biomaterials to determine their microstructural properties.	C4	4		1	1, 2	T, Q, R
CO3	Be able to investigate metallic biomaterials to determine their biochemical (corrosion) property.		4		1	1, 2	T, Q, R
CO4	Be able to **design, develop and test** synthetic biomaterials for biomedical applications.	C6	3,10		1	5	PR, Pr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Determination of elasticity and Young's modulus, stress and strain analysis, Tensile test, compressive test, creep test, fatigue test, torsion test, shear test, ductility test, bending test, impact test, corrosion test, hardness test, indentation test, etch test, metallurgical microscopic analysis, surface topography and porosity, hydrogel and composite biomaterial fabrication, and FTIR characterization of biomaterials.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to investigate different biomaterials to determine their mechanical properties.				3								
CO2	Be able to investigate different biomaterials to determine their microstructural properties.				3								
CO3	Be able to investigate metallic biomaterials to determine their biochemical (corrosion) property.				3								
CO4	Be able to **design, develop and test** synthetic biomaterials for biomedical applications.			3							2		

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to biomaterials lab, laboratory techniques, laboratory rules. Introduction to polymer biomaterials	Report, Lab Test, Quiz, Viva
2	Preparation and synthesis of hydrogel	
3	Physical property and qualitative assessment of the hydrogel. Preparation of hydrogel for lyophilization and degradation test	

4	Analysis of the lyophilized hydrogel and water absorption test Measurement of the degradation test	
5	Measurement of water absorption test and degradation test Preparation for FTIR analysis and tensile test	
6	FTIR analysis of hydrogels	
7	Tensile testing of hydrogels	
Midterm Break		
8	Lab Test 1	Report, Lab Test, Quiz, Viva
9	Preparation and fabrication of bone cement	
10	Compression analysis of bone cement	
11	Three point bending of bone cement/other relevant composite/biological materials	
12	UV-VIS spectrophotometry analysis of different concentrations of solutions	Project, Presentation
13	Optical property measurement of different materials	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (30%)	Report	20%	CO1, CO2	C4
	Class Participation	10%	CO1, CO2, CO3	C4, C6
Final Exam (70%)	Lab Test	15%	CO1, CO2	C4
	Project	15%	CO3	C6
	Quiz	30%	CO1, CO2	C4
	Viva	10%	CO1, CO2	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Elements of Materials Science and Engineering 6th Edition. by L. H. Van Vlack

REFERENCE SITE

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COURSE INFORMATION

Course Code Course Title	: BME 318 : Biomedical Engineering Design Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 104
Course Title: CAD in Biomedical Engineering Sessional

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the application of design tools to model prototypes and develop the individual project ideas and full completion of an individual project.

OBJECTIVE

The aim of this course is to enhance student's idea about project and develop their capabilities of project management.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** modern engineering tools to develop projects to enhance healthcare facilities.	C3	3, 5	1	-	1	T, Q, R
CO2	Be able to **analyze** a complex problem and using engineering tools and knowledge would be able to formulate a suitable solution.	C4	2, 5	1	-	1, 2	T, Q, R, ASG
CO3	Be able to **design** and develop devices and equipment to improve healthcare facilities.	C6	3	1, 3	-	5	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

This course exposes students to the entire design process from problem definition to prototype validation. The course is organized like a biomedical engineering company, with projects sponsored by real clients from the Medical School, Dental School, College of Engineering research labs, and local industry. This course comprises six main components:

1. Problem Definition – Students will generate/ be assigned a project idea and expected to decompose the problem, generate design specifications, and plan out the project.
2. Concept Generation and Evaluation – Students will use brainstorming and decision evaluation tools to generate and evaluate solutions to reach a design consensus.
3. Detailed Design – Students will generate a paper design of their proposed prototype including device specifications, key materials and components, detailed drawings, and principles of operation with all choices justified and supported through proof-of-concept.
4. Fabrication and Validation – Students will fabricate and conduct testing of their prototype, assess the degree to which the prototype meets the design specifications, and recommend design modifications to improve the prototype.

5. Project Management – Students will create and update a project timeline, budget, design history file, and maintain engineering notebooks throughout all phases of the project.
6. Technical Communication – Students will be required to describe, explain, and support the progress and solutions of their project at all phases of the design process.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** modern engineering tools to develop projects to enhance healthcare facilities.			2		3							
CO2	Be able to **analyze** a complex problem and using engineering tools and knowledge would be able to formulate a suitable solution.		2			3							
CO3	Be able to **design** and develop devices and equipment to improve healthcare facilities.			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction, Course overview, Evaluation process, Form group	Report, Assignment, Lab Test, Quiz, Viva
2	Discussion on few proposed projects and project scope	
3	Discussion on project idea and design consideration	
4	Idea based project presentation, budget and timeline Define need and project scope, design requirements	
5	Model generation, usability testing, engineering analysis	
6	Finalization of design with detailed drawing and computational validation testing	
7	Finalization of Project and start the prototype fabrication process	
	Midterm Break	
8	Prototype fabrication review and troubleshooting	Report, Lab Test, Quiz, Viva
9	Prototype verification and validation testing	
10	Prototype verification and validation testing	
11	Draft Report Submission and Review	
12	Project Submission with complete documentation (Drawing, user manual, report and design history file)	
13	Presentation	
14	Project Showcasing	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Robbinson C.J., Rehabilitation Engineering. CRC press 1995
2. Gerald E. Miller, Artificial Organs, Morgan & Claypool Publishers, 2006

REFERENCE BOOKS

1. Bronzino. Joseph, Handbook of biomedical engineering. CRC; 2 Sub editions, 1999
2. BallabioE.etal, Rehabilitation Engineering. IOS press 1993.

REFERENCE SITE

COURSE INFORMATION

Course Code Course Title	: BME 300 : Industrial Training	Lecture Contact Hours Credit Hours	: 1.50 : 1.50

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

Training in industry, hospital or healthcare organization will be conducted for a duration of 4 weeks at the end of level 3 term 2. Students will learn how to apply their skills as a biomedical engineer in a professional setting and will undergo extensive training in preparation for their role in the industry, hospital, or healthcare facilities. The training can be arranged by the department.

OBJECTIVE

2. To learn and explore the different technical aspects and management of health-related organizations.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the role of a biomedical engineer in their respective fields	C2	6, 12	-	7	7	R, Pr
CO2	Be able to **evaluate** various technical aspects of biomedical equipment	C5	9, 10	2	-	7	R, Pr
CO3	Be able to **learn** and **apply** professional ethics, responsibilities and the norms of the engineering practice.	C3	8, 12	-	7	7	R, Pr
CO4	Be able **to comprehend** and **write** effective reports, design documentation, make effective presentations and give and receive clear instructions.	C6	10	-	-	7	R, Pr
CO5	Be able to **apply** their biomedical engineering knowledge in a professional setting	C3	9, 11, 12	1	-	6	R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

4 weeks of industrial training at an industry, hospital, or healthcare organization. This is obligatory for the completion of B.Sc. course. An evaluation report from the industry is to be submitted at the end of the training and accordingly to be incorporated in the tabulation sheet.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the role of a biomedical engineer in their respective fields						3						3
CO2	Be able to **evaluate** various technical aspects of biomedical equipment									2	3		
CO3	Be able to **learn** and **apply** professional ethics, responsibilities and the norms of the engineering practice.								3				3
CO4	Be able **to comprehend** and **write** effective reports, design documentation, make effective presentations and give and receive clear instructions.										3		
CO5	Be able to **apply** their biomedical engineering knowledge in a professional setting									3		3	3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	2
Final Presentation	1
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method, Training.

COURSE SCHEDULE

Week	Content	Assessment
1	Industrial Training at an industry, hospital, or healthcare organization	**Continuous Assessment, Report**
2	Industrial Training at an industry, hospital, or healthcare organization	
3	Industrial Training at an industry, hospital, or healthcare organization	
4	Industrial Training at an industry, hospital, or healthcare organization	

Final Presentation				
ASSESSMENT STRATEGY				
Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C2, C3, C5
	Class Participation	20%	CO1, CO2, CO3	C2, C3, C5
Final Exam (60%)	Final Presentation	60%	CO1, CO2, CO3	C2, C5
Total Marks		100%		
(CO = Course Outcome, C = Cognitive Domain)				
TEXT BOOKS				
-				
REFERENCE SITE				

6.1.27 BME 401 Diagnostic and Therapeutic Equipment

COURSE INFORMATION			
Course Code Course Title	: BME 401 : Diagnostic and Therapeutic Equipment	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
BME 207: Biomedical Instrumentation and Measurements			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The course aims to teach students about various diagnostic and therapeutic equipment. The course covers the following modules: cardiac equipment, neurological equipment, skeletal muscular equipment, respiratory equipment, diathermy, drug delivery systems, incubator, some special diagnostic techniques and patient monitoring.			
OBJECTIVE			
The objective of the course is to make the students familiarized with the medical devices used in healthcare for diagnostic and therapeutic purposes. Understand the principles of operation and identify the application areas. Also to make the students able to analyze, troubleshoot, repair, and calibrate diagnostic and therapeutic equipment.			
COURSE OUTCOMES & GENERIC SKILLS			

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be **familiar** with the various equipment used in Diagnostic and therapeutic purposes.	C1	1	1	-	1	T, F
CO2	Be able to **understand** the principles of various diagnostic and therapeutic equipment	C2	1	1	-	1	T, F
CO3	Be able to **analyze**, troubleshoot, repair, and calibrate diagnostic equipment.	C4	2, 4	1,3	-	1,3	MID, F
CO4	Be able to **analyze**, troubleshoot, repair, and calibrate therapeutic equipment	C4	2, 4	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Diagnostic and Therapeutic Equipment: Definition, Difference between diagnostic and therapeutic equipment, Electrocardiograph (ECG) Machine: Principle and construction, Ambulatory Monitoring System: Principle and application, Phonocardiography, Cardiac Pacemaker, Defibrillator: Principle, types, application, risk factors, EEG recording system, Principle of MEG, Muscle & Nerve stimulators, EMG Machine, EMG Bio-Feedback Instrumentation, Ventilator: Principle, construction, types, modes of operation, testing and calibration., CPAP, BiPAP: Principle and applications, High Flow Nasal Cannula (HFNC): Principle and applications, Thermography – Recording and clinical application., Electro-surgery machine: Principle, applications, risk factors, Principles of Cryogenic technique and application, Syringe and Infusion pumps, Endoscopy, Laparoscopy: Principle, and application, Patient monitoring system, Dialysis Machine, Haemodialysis machine: principles and construction, Application and principle of Lithotripsy, Co-60 Units: Principle, and applications, Cyclotron: Principle and applications, Linear Accelerator (LINAC), Optical Coherence Tomography (OCT), Opthalmoscope, Special Diagnostic Techniques, Near-Infrared Spectroscopy (NIRS), ICU/CCU/HDU Equipment and setup, Heart Lung Machine: Need for the unit, principle, functioning of bubble, disc type and membrane type oxygenators,, finger pump, roller pump, electronic monitoring of functional parameters, Safety, maintenance and repair of biomedical equipment, Current trends in clinical engineering

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be **familiar** with the various equipment used in Diagnostic and therapeutic purposes.	3											
CO2	Be able to **learn** the principles of various diagnostic and therapeutic equipment	3											
CO3	Be able to **analyze**, troubleshoot, repair, and calibrate diagnostic equipment.		3		3								
CO4	Be able to **analyze**, troubleshoot, repair, and calibrate therapeutic equipment		3		3								

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning	 42 - -
Self-Directed Learning Non-face-to-face learning Revision of the previous and (or) subsequent lecture at home Preparation for final examination	 42 21 21
Formal Assessment Continuous Assessment Final Examination	 2 3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction + Cardiac equipment**	**CT – 1, Final**
Lecture 1	Introduction to Diagnostic and Therapeutic Equipment: Definition, Difference between diagnostic and therapeutic equipment	
Lecture 2 Lecture 3	Electrocardiograph (ECG) Machine: Principle and construction	
2	**Cardiac equipment**	
Lecture 4	Ambulatory Monitoring System: Principle and application	
Lecture 5	Phonocardiography + Cardiac Pacemaker	
Lecture 6	Defibrillator: Principle, types, application, risk factors	
3	**Neurological equipment + Skeletal muscular equipment**	
Lecture 7	EEG recording system + Principle of MEG	
Lecture 8	Muscle & Nerve stimulators	
Lecture 9	EMG Machine + EMG Bio-Feedback Instrumentation	
4	**Respiratory Equipment**	**Midterm, Final**
Lecture 10 Lecture 11 Lecture 12	Ventilator: Principle, construction, types, modes of operation, testing and calibration.	
5	**Respiratory Equipment**	
Lecture 13 Lecture 14	CPAP, BiPAP: Principle and applications	
Lecture 15	High Flow Nasal Cannula (HFNC): Principle and applications	
6	**Diathermy and Thermography**	
Lecture 16	Thermography – Recording and clinical application.	
Lecture 17 Lecture 18	Electro-surgery machine: Principle, applications, risk factors	

7	**Special equipment**	
Lecture 19	Principles of Cryogenic technique and application	
Lecture 20		
Lecture 21	Syringe and Infusion pumps	
	Midterm Break	
8	**Special equipment**	**CT – 2, Final**
Lecture 22	Endoscopy + Laparoscopy: Principle, and application	
Lecture 23		
Lecture 24	Patient monitoring system	
9	**Dialysis Machine**	
Lecture 25	Haemodialysis machine: principles and construction	
Lecture 26		
Lecture 27	Application and principle of Lithotripsy	
10	**Radiotherapy Equipment**	
Lecture 28	Co-60 Units: Principle, and applications	
Lecture 29	Cyclotron: Principle and applications	
Lecture 30	Linear Accelerator (LINAC)	
11	**Special Diagnostic Techniques**	**CT – 3, FINAL**
Lecture 31	Optical Coherence Tomography (OCT)	
Lecture 32		
Lecture 33	Opthalmoscope	
12	**Special Diagnostic Techniques**	
Lecture 34	Near-Infrared Spectroscopy (NIRS)	
Lecture 35		
Lecture 36	ICU/CCU/HDU Equipment and Setup	
13	**Heart-Lung Machine**	**FINAL**
Lecture 37	Heart Lung Machine: Need for the unit, principle, functioning of bubble, disc type and membrane type oxygenators	
Lecture 38	Heart Lung Machine: finger pump, roller pump	
Lecture 39	Heart Lung Machine: electronic monitoring of functional parameters.	
14	**Safety, Maintenance, Repair of Biomedical Equipment**	
Lecture 40	Safety	
Lecture 41	Maintenance and Repair	
Lecture 42	Current trends in clinical engineering	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C1, C2, C4
	Class Participation	5%	CO3	C4
	Midterm	15%	CO2	C2
Final Exam		60%	CO 1	C1

		CO 2	C2
		CO 3	C4
		CO 4	C4
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain)
TEXT BOOKS
1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill. 2. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.
REFERENCE BOOKS
1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
REFERENCE SITE
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6.1.28 BME 403 Molecular Biology for Engineers

COURSE INFORMATION			
Course Code Course Title	: BME 403 : Molecular Biology for Engineers	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
	Course Code : BME 201 Course Titile : Human Physiology	Course Code : BME 203 Course Titile : Biochemistry	
CURRICULUM STRUCTURE			
	Outcome Based Education (OBE)		
SYNOPSIS/RATIONALE			
	The aim of this course is to present the knowledge of molecular cell biology to engineering students especially students of Biomedical Engineering. The course emphasizes conceptual appreciation of the molecular interplays which are the basis of "chemical processes" in living systems. The objective of the course is to provide students with a comprehensive and concise overview of biological science with emphases on its relationship with biomedical engineering. The course covers the following modules: DNA, chromosomes, RNA, protein, genetics, gene expression		
OBJECTIVES			
	1. To be able to impart basic knowledge on life at molecular level 2. To be able to find the molecular reasons of physiological disorders 3. To be able to suggest molecular solutions of physiological disorders		

COURSE OUTCOMES & GENERIC SKILLLS

No.	Course outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** fundamental concepts on molecular cell biology, biochemistry, and genetic engineering	C1-C2	1	1		1, 3	T, F
CO2	Be able to **apply** the principles of molecular methods in a design to	C3	3	3		5	T, Mid Term, F

	sense, study or control a biological system.						
CO3	Be able to **analyze** a design involving a quantitative molecular application used in a research, biomedicine or healthcare setting.	C4	4	1		3	ASG, Pr
	(CP-Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR-Project; Q-Quize; ASG-Assignment; Pr-Presentaion; R-Report, F-Final Exam)						

COURSE CONTENT

Introduction: Introduction to molecular biology, molecular perception of living beings, application in Biomedical Engineering

The Structure of DNA: Components of nucleic acid based on different structure, Significance of 5’ to 3’,

Super coiling of DNA

Genomic Organisation: from Nucleotides to Chromatin,

The Versatility of RNA and Gene to Protein: Description of different structures of RNA, The Central dogma, Description of different protein structures.

DNA replication: Replication process, proofreading and termination

DNA repair and recombination: DNA damage and removal of DNA damage

Recombinant DNA technology and molecular cloning: Cloning and RFLP

Tools for analyzing gene expression: Reporter gene, mutagenesis, expression and localization

Transcription: Mechanism of transcription, transcription factors, transcriptional coactivators and corepressors

Epigenetics: Epigenetic markers, epigenetic control of transposable elements

Translation: Initiation of translation, elongation, termination and post-translational control

Genome analysis and Gene Sequencing: DNA typing and Editing, Genomics and Proteomics, Techniques in Gene sequencing

SKILL MAPPING (CO-PO MAPPING)

No.	Course outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** fundamental concepts on molecular cell biology, biochemistry, and genetic engineering	3											
CO2	Be able to **apply** the principles of molecular methods in a design to sense, study or control a biological system.			2									
CO3	Be able to **analyze** a design involving a quantitative molecular application used in a research, biomedicine or healthcare setting.				3								

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for **CO-PO** mapping

Mapping	**Corresponding Level of matching**	**Justifications**

CO1-PO1	3	The knowledge of basic mathematics, science and bioengineering has to be applied to describe molecular functions of cells in human body.
CO2-PO3	2	Knowledge of contemporary issues regarding the molecular mechanisms of diseases or knowledge of molecular solutions of these diseases are required.
CO3-PO2	2	Knowledge of analyzing biological data, knowledge of identifying problems are instrumental to ensure better health.

TEACHING LEARNIN STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical/Tutorial/Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-Face-to Face Learning	42
Revision of the previous lecture at home	21
Preparation for the final examination	21
Formal Assessment	
Continuous assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Course introduction**	CT – 1
Lecture 1	Introduction to molecular biology	
Lecture 2	Molecular perception of living beings	
Lecture 3	Application in Biomedical Engineering	
2	**The Structure of DNA**	
Lecture 4	Components of nucleic acid based on different structure	
Lecture 5	Significance of 5’ to 3’	
Lecture 6	Supercoiling of DNA	
3	**Genomic Organization: from Nucleotides to Chromatin**	
Lecture 7	Eukaryotic genome	
Lecture 8	Bacterial genome	
Lecture 9	RNA based genome	
4	**The Versatility of RNA and Gene to Protein**	
Lecture 10	Description of different structures of RNA	
Lecture 11	The Central dogma	
Lecture 12	Description of different protein structures and identification	
5	**DNA replication**	
Lecture 13	Principles of replication process	
Lecture 14	Replication licensing: DNA only replicates once per cell cycle Duplex unwinding at replication forks	

Lecture 15	Proofreading and termination	CT-2
6	**DNA repair and recombination**	
Lecture 16	Types of mutations and their phenotypic consequences	
Lecture 17	General classes of DNA damage	
Lecture 18	Repair of single base changes and structural distortions by removal of DNA damage Double-strand break repair by removal of DNA damage	
7	**Recombinant DNA technology and molecular cloning**	
Lecture 19	Cutting and joining DNA	
Lecture 20	Molecular cloning	
Lecture 21	Restriction fragment length polymorphism (RFLP) DNA sequencing	
8	**Tools for analyzing gene expression**	Midterm
Lecture 22	Reporter genes	
Lecture 23	In vitro mutagenesis	
Lecture 24	Analysis at the level of gene transcription: RNA expression and localization Analysis at the level of translation: protein expression and localization	
9	**Transcription**	
Lecture 25	Mechanism of transcription	
Lecture 26	Transcription factors	
Lecture 27	Transcriptional coactivators and corepressors	
10	**Epigenetics and monoallelic gene expression**	
Lecture 28	Epigenetic markers	
Lecture 29	Genomic imprinting	
Lecture 30	Epigenetic control of transposable elements	
11	**RNA processing and post-transcriptional gene regulation**	
Lecture 31	Group I and group II self-splicing introns	
Lecture 32	Alternative splicing	
Lecture 33	RNA editing	
12	**Translation**	CT – 3, FINAL
Lecture 34	Initiation of translation	
Lecture 35	Elongation	
Lecture 36	Termination and post-translational control	
13	**Genetically modified organisms: use in basic and applied research**	
Lecture 37	Transgenic mice	
Lecture 38	Gene-targeted mouse models	
Lecture 39	Applications of transgenic animal technology	
14	**Genome analysis and Gene Sequencing**	
Lecture 40	DNA typing and Editing	
Lecture 41	Genomics and Proteomics	
Lecture 42	Techniques in Gene sequencing	

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy

Continuous assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3
	Class participation	5%	CO1	C1, C2
	Midterm	15%	CO3	C4
Final Exam		60%	CO1	C1, C2
			CO2	C3
			CO3	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor Domain, A= Affective Domain)

TEXT BOOKS

1. Fundamental Molecular Biology by Lizabeth A. Allison
2. Lehninger Principles of Biochemistry- 4th Edition, by Albert L. Lehninger, David L. Nelson, and Michael M. Cox.

REFERENCE BOOKS

1. Molecular Cell Biology by Lodish, Berk, Matsudaira, Kaiser Krieger, Scott, Zipursky, Darnell.
2. Introduction to Molecular Biology and Genetic Engineering by Oliver Brandenberg, Zephaniah Dhlamini Alessandra Sensi, Kakoli Ghosh, Andrea Sonnino

6.1.29 BME 404 Molecular Biology for Engineers Sessional

COURSE INFORMATION

Course Code Course Title	: BME 404 : Molecular Biology for Engineers Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE

Course Code: BME 406
Course Title: Molecular Biology for Engineers

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers routinely used molecular biology techniques used in diagnostics and laboratory. Topics cover both DNA based assays such as PCR, electrophoresis and protein-based assays such as ELISA and SDS-PAGE In-vitro cell culture techniques are also covered

OBJECTIVE

This course aims to introduce the students to basic molecular biology techniques, their applications and methodologies.

COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **extract, quantify** and **analyze** nucleic acids (DNA/RNA) using amplification techniques	C3, C4	4, 5	-	1	1	T, Q, R
CO2	Be able to **conduct** protein-based assays (ELISA, flow cytometer)	C3, C4	4, 5	-	1	1	T, Q, R
CO3	Be able to **apply** cell culture techniques to **quantify** and **analyze** cell growth	C3, C4	2, 5	-	1	1	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Extraction of DNA and RNA using commercially available DNA/RNA extraction kits. Identification of gene of interest using real-time PCR technique. Gene length quantification using gel electrophoresis. Protein extraction using kits and identification using SDS-PAGE techniques. Antigen/antibody detection using flow cytometry techniques. In-vitro cell culture in both 2D and 3D substrates with cell counting and differentiation using flow cytometry.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **extract, quantify** and **analyze** nucleic acids (DNA/RNA) using amplification techniques				3	3							
CO2	Be able to **conduct** protein-based assays (ELISA, flow cytometer)				3	3							
CO3	Be able to **apply** cell culture techniques to **quantify** and **analyze** cell growth		3			3							

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction to general laboratory techniques and laboratory instruments routinely used in molecular biology labs	Report, Lab Test, Quiz, Viva
2	Isolation of PBMCs from whole blood followed by cell staining	
3	Extraction of genomic DNA from PBMCs using different extraction techniques	
4	Extraction of total RNA from PBMCs using a commercial RNA isolation kit	
5	Amplification and analysis of the extracted DNA sample using PCR	
~~6~~	Amplification and analysis of the extracted DNA sample using RT-PCR	
7	Identification of PCR products using gel electrophoresis	
	Midterm Break	
8	Mid Lab Test	Report, Lab Test, Quiz, Viva
9	Isolation of PBMCs from whole blood followed by total WBC culture	
10	Qualitative assessment of total WBC culture followed by cell staining for flow cytometry analysis	
11	Quantification of T/B cell surface markers using flow cytometer	
12	Receptor-ligand binding assay using ELISA or a rapid diagnostic kit	
13	Lab Test	
14	Quiz and Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C3
	Quiz	30%	CO1, CO2, CO3	C4, C3
	Viva	10%	CO1, CO2, CO3	C4, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Molecular Biomethods Handbook, 2nd Edition, John M. Walker, Humana Press
2. Fundamental Molecular Biology, Lizabeth A. Allison, Blackwell Publishing

REFERENCE SITE

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6.1.30 BME 405 Healthcare Technology Management

COURSE INFORMATION

Course Code Course Title	: BME 405 : Healthcare Technology Management (HTM)	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: BME 401
Course Title: Diagnostic and therapeutic equipment
Course Code: BME 300
Course Title: Industrial Training

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course provides students with a basic understanding of the principles of healthcare technology planning and management - assessment, budgeting, acquisition, deployment, education/training, patient safety, maintenance, and replacement/disposal, hospital planning and management. Planning and management will focus on medical devices, clinical information systems, and converged technologies.

OBJECTIVE

1. To understand the basic guiding principles of healthcare technology planning and management
2. To provide a methodology for improving the quality of medical devices, clinical information systems and converged technology through effective planning and management
3. To help students better communicate with technical staff, clinicians, regulators, administrators, and technology vendors.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods

CO1	Be able to **understand** the management, administration and regulation of healthcare technology.	C2	11	-	-	1	T, F
CO2	Be able to **analyze** the clinical effectiveness, efficiency and safety of patient and surrounding individuals.	C4	2, 8	-	-	6	T, F
CO3	Be able to **evaluate** and manage the information regarding identification of biomedical and hospital technology planning, procurement and operation requirements.	C5	4, 11	-	-	7	MID, F
CO4	Be able to **manage** environmental considerations and sustainable engineering solutions to healthcare.	C2	7	-	-	7	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Healthcare Technology Overview: Introduction to healthcare technology management (HTM), Healthcare and introduction to digital and mobile health, Leveraging technology and innovation to improve healthcare, Hospital planning and management, Classification of hospitals and hospital systems, their role, functions, role of biomedical engineering, aspects of hospital services, Introduction to Norms and standards (e.g. HBN / FGI / AHA / ICRP / JCI / FDA / CE/ ISO), methods to monitor the standards, Hospital planning, location, orientation, budgeting, communication within the hospital and outside the hospital.

Safety measure in Healthcare Facility: Infection Control, Central Medical Gas System design, HVAC system, Concept of Ambulance services, Laundry services, Civil Assets, CSSD, Electrical factors in hospital design: voltage stabilizers, uninterrupted power supply for intensive care UNITS and computerized monitoring UNITS, safety precautions, interference of systems, protection, grounding of ECG, EEG, EMG and therapeutic equipment.

Equipment service and maintenance: Biomedical equipment services, their purchase, servicing and maintenance, condemned equipment disposal, training of men for medical equipment's, preventive and periodical maintenance procedures, life cycle of medical equipment.

Electronic Medical Record & Hospital Management Strategy for Healthcare: Computer based information management in hospitals, application, administration /discharge records of patients – patients billing, maintenance of patients' record, their history, and maintenance of inventory of medicines and drugs purchase, Hospital information system and picture archiving system (PACS), Telemedicine-Remote presence monitoring, companion diagnostics and outlook for personalized medicine.

Support services in Healthcare: Disaster management, Fire Fighting system, Elements of Safety, Orientation to Laboratory Safety, Radiation hazards, Radiation detection, Safety measures, Standards, Flammables and Explosives, Material Safety, Waste management.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the management, administration and regulation of healthcare technology.											3	
CO2	Be able to **analyze** the clinical effectiveness, efficiency and safety of		2						2				

	patient and surrounding individuals.												
CO3	Be able to **evaluate** and manage the information regarding identification of biomedical and hospital technology planning, procurement and operation requirements.								2			3	
CO4	Be able to **manage** environmental considerations and sustainable engineering solutions to healthcare.							3					

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to Healthcare Technology Management (HTM)**	**CT – 1, Final**
Lecture 1	HTM overview	
Lecture 2	Roles and functions of HTM in healthcare facilities	
Lecture 3	Strategy and management thinking	
2	**Healthcare Quality Concepts**	
Lecture 4	Introduction to quality concepts	
Lecture 5	Aspects of quality concepts	
Lecture 6	Dimensions of quality concepts	
3	**Healthcare Regulations and Standards**	
Lecture 7	Overview of various norms and standards	
Lecture 8	Uses of regulations and standards in healthcare facilities	
Lecture 9	Methods to monitor standards	
4	**Inventory and Risk Management**	
Lecture 10	Overview of various safety measures in healthcare	
Lecture 11	Overview of various safety measures in healthcare	

Lecture 12	Electrical factors in hospital design	**Midterm, Final**
5	**Overview of Hospitals**	
Lecture 13	Introduction to hospital	
Lecture 14	Classification of hospitals and hospital systems	
Lecture 15	Roles and function of hospital departments	
6	**Intensive Care Unit/ OT Module**	
Lecture 16	Overview of common apparatus in ICU and OT	
Lecture 17	Levels and types of care units	
Lecture 18	Medical OT setup (Budget and Planning)	
7	**Hospital planning, Financial Management and Material Management**	
Lecture 19	Hospital planning: Location, Orientation, and Budgeting	
Lecture 20	Hospital planning: Location, Orientation, and Budgeting (Continue)	
Lecture 21	Audit, Financial Management and Material Management	
Midterm Break		
8	**Biomedical Equipment Management – Part I**	**CT – 2, Final**
Lecture 22	Biomedical equipment purchase	
Lecture 23	Planned replacement projects (planning, tender, procurement, commissioning and discussion)	
Lecture 24	Managing equipment trials and servicing maintenance	
9	**Biomedical Equipment Management – Part II**	
Lecture 25	Healthcare technology assessment, advert event investigation and medical device safety alert	
Lecture 26	Condemned equipment disposal, Training services	
Lecture 27	Preventive and periodic maintenance	
10	**Life Cycle Management of Medical Equipment**	
Lecture 28	Managing medical equipment over its life cycle (life cycle medical equipment cost, maintenance cost, replacement planning)	
Lecture 29	Approaches to financing the life cycle of medical equipment (Capital-funded support, revenue funded support, renting, leasing equipment etc.)	
Lecture 30	Extracting optimal benefit from medical equipment over its life cycle (asset management: buy the right equipment; operation and user support; maintenance)	
11	**Electronic Medical Record & Hospital Management Strategy**	**CT – 3, FINAL**
Lecture 31	Computer controlled information management in hospitals	
Lecture 32	Maintenance of inventory medicine, patient record system	
Lecture 33	Patient billing, maintenance of patients' records and history	
12	**Hospital Information System and Picture Archiving System (PACS)**	
Lecture 34	Overview of HIS, Laboratory Information System (LIS) and Electronic Medical Health Record (EMR)	
Lecture 35	Significance of PACS, Overview of DICOM, PACS Architecture for Imaging Modalities	

Lecture 36	PACS Architecture for Care Unit Equipment and Diagnosis Equipment, Integration of PACS with HIS and EMR	
13	**Support Services, Health Safety and Waste Management**	**FINAL**
Lecture 37	Disaster management, firefighting system overview, basic elements of safety regulations, Infectious Control	
Lecture 38	Safety regulation, laboratory safety, material safety, HVAC system, CSSD unit	
Lecture 39	Radiation hazards and detection system, safety measures, flammables and explosives; Waste management	
14	**Digital and Mobile Health (Telemedicine)**	
Lecture 40	Introduction to digital and mobile healthcare system	
Lecture 41	Leveraging technology and innovation to improve healthcare	
Lecture 42	iRobot and the importance of telemedicine in healthcare improvement, personalize medicine technology	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C2, C4, C2
	Class Participation	5%	-	-
	Midterm	15%	CO3	C5
Final Exam		60%	CO 1	C2
			CO 2	C4
			CO 3	C5
			CO 4	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Healthcare Technology Management - A Systematic approach by Blackett, Paul, McCarthy, Justin
2. Healthcare Technology Management Systems: Towards a New Organizational Model for Health Services by Rossana Rivas and Luis Vilcahuaman

REFERENCE SITE

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6.1.31 BME 407 Rehabilitation Engineering

COURSE INFORMATION

Course Code Course Title	: BME 407 : Rehabilitation Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the major topics/subtopics that include impairments, disabilities and handicaps (identification and assessment); characterizing engineering concepts in sensory and motor rehabilitation; engineering concept in communication disorders; rehabilitation for locomotion, visual, speech & hearing; artificial limb and hands, prosthetic heart valves; externally powered and controlled orthotics and prosthetics; myoelectric hand and arm prostheses; Marcus intelligent hand prostheses, gait study and spinal rehabilitation.

OBJECTIVE

The goal of this course is to present rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. The focus of this course lies in the restoration and treatment of the human sensory and vegetative systems.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** human disorders (impairments, disabilities and handicaps)	C1	2	1	-	1,3	T, F
CO2	Be able to **investigate** and **evaluate** human disorders (impairments, disabilities and handicaps)	C5	4	1	-	1,3	T, F
CO3	Be able to **select** appropriate method(s) of rehabilitation	C4	5	1	-	1	MID, F
CO4	Be able to **develop** suitable assistive technology in providing rehabilitation supports to the disable.	C6	3,7	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Rehabilitation Engineering, Types of physical impairments, Principles of Rehabilitation, Measurement and analysis of human movement, clinical practice of rehabilitation engineering, Motor, Sensor and Communication disorders, Characterizing engineering concepts in sensory and motor rehabilitation, Engineering concept in communication disorders, Rehabs for locomotion, visual, speech & hearing, Spinal rehabilitation, Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand, Marcus intelligent hand prostheses.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** human disorders (impairments, disabilities and handicaps)		3										
CO2	Be able to **evaluate** human disorders (impairments, disabilities and handicaps)				3								
CO3	Be able to **select** appropriate method(s) of rehabilitation					3							
CO4	Be able to **develop** suitable assistive technology in providing rehabilitation supports to the disables.			3				2					

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	**Topic**	**Assessment**
1	**Introduction to Rehabilitation Engineering**	**CT – 1, Final**
Lecture 1	Basics of Impairment, Disability & Handicap, Introduction to Rehabilitation Engineering	
Lecture 2	History, Goals and Types of Rehabilitation Engineering	
Lecture 3	Assistive Technology and Overview of Development on Rehabilitation Engineering	
2	**Analysis of Human Motion**	
Lecture 4	Rigid Body Motion	

Lecture 5	Forms of Motion, Anatomical Reference Position, Reference Planes, Reference Axes	
Lecture 6	Joint Movements	
3	**Sensory & Motor Rehabilitation**	
Lecture 7	Basics of Human Senses	
Lecture 8	Sensory Rehabilitation, Neurological Rehabilitation	
Lecture 9	Principles Governing Neuroplasticity, Motor Rehabilitation	
4	**Rehabilitation for Communication Disorders – Part I**	**Midterm, Final**
Lecture 10	Communication Process	
Lecture 11	Fundamentals of Communication Disorders	
Lecture 12	Autism, Causes, Characteristics, Types and Clinical Practices of Speech Impairments	
5	**Rehabilitation for Communication Disorders – Part II**	
Lecture 13	Introduction to Language Impairments	
Lecture 14	Causes and Types of Language Impairments, Determining the Presence of Communication Disorders	
Lecture 15	Augmentative and Alternative Communication (AAC)	
6	**Rehabilitation for Locomotion Disorders**	
Lecture 16	Introduction to Locomotion	
Lecture 17	Media for Locomotion – Supports & Problems; Exoskeleton, Endoskeleton	
Lecture 18	Consequences of impaired musculoskeletal system on support & locomotion and their solutions	
7	**Rehabilitation for Visual Disorders - Part I**	
Lecture 19	Introduction to visual disorder	
Lecture 20	Causes of visual impairments	
Lecture 21	Goals and Assessment of visual rehabilitation	
	Midterm Break	
8	**Rehabilitation for Visual Disorders - Part II**	**CT – 2, Final**
Lecture 22	Strategies for low vision management	
Lecture 23	Optical devices for visual rehabilitation	
Lecture 24	Non-optical Devices For visual rehabilitation	
9	**Rehabilitation for Hearing Disorders – Part I**	
Lecture 25	Basics of Hearing Process	
Lecture 26	Degree and Type of Hearing Impairments	
Lecture 27	Assessment and Risk Factors of Hearing Impairments	
10	**Rehabilitation for Hearing Disorders – Part II**	
Lecture 28	Non-Implantable Hearing Devices	
Lecture 29	Implantable Hearing Devices	
Lecture 30	Implantable Hearing Devices	
11	**Artificial Limb – Part I**	
Lecture 31	Overview of artificial limb	
Lecture 32	Characteristics and consideration of an Ideal Prosthesis	
Lecture 33	Types of orthoses and prostheses	
12	**Artificial Limb – Part II**	
Lecture 34	Terminal Devices	

Lecture 35	Prosthetic Suspension	**CT – 3, FINAL**
Lecture 36	Amputation & Prosthesis Fitting Procedure	
13	**Rehabilitation for Heart Valve Disorder**	**FINAL**
Lecture 37	Symptoms and causes of Heart Valve disorder	
Lecture 38	Types of heart valves	
Lecture 39	Technical aspects of Heart valves	
14	**Rehabilitation for Spinal Disorder**	
Lecture 40	Spinal Function and Injury	
Lecture 41	Risk Factors and Classification of Spinal Injury	
Lecture 42	Goal and therapies for Spinal Rehabilitation	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C1, C5, C6
	Class Participation	5%	CO3	C4
	Midterm	15%	CO3	C4
Final Exam		60%	CO 1	C1
			CO 2	C5
			CO 3	C4
			CO 4	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Robbinson C.J., Rehabilitation Engineering. CRC press 1995
2. Gerald E. Miller, Artificial Organs, Morgan & Claypool Publishers, 2006

REFERENCE BOOKS

1. Bronzino. Joseph, Handbook of biomedical engineering. CRC; 2 Sub editions, 1999
2. BallabioE.etal, Rehabilitation Engineering. IOS press 1993.

REFERENCE SITE

https://classroom.google.com/u/0/c/NDQzMzQ1NDQzNjla

6.1.32 BME 409 Tissue Engineering

COURSE INFORMATION

Course Code	: BME 409	Lecture Contact Hours	: 3.00
Course Title	: Tissue Engineering	Credit Hours	: 3.00

PRE-REQUISITE

Course Code : BME 201 Course Titile : Human Physiology	Course Code : BME 405 Course Titile : Molecular Biology for Engineers

<table>
<tr><td colspan="8">CURRICULUM STRUCTURE</td></tr>
<tr><td></td><td colspan="7">Outcome Based Education (OBE)</td></tr>
<tr><td colspan="8">SYNOPSIS/RATIONALE</td></tr>
<tr><td></td><td colspan="7">Although lives of thousands of people are saved by reconstructive surgery, many people are still waiting for organ donations. In the last decade Tissue engineering has emerged as a new discipline within reconstructive surgery, with focus on in vitro fabrication of living, human spare parts. Tissue engineering encompasses several different sciences such as biology, chemistry, material science, engineering, immunology and transplantation. The course in Tissue engineering provides a general understanding of tissue growth and development as well as the tools and theoretical information necessary to design tissues and organs.</td></tr>
<tr><td colspan="8">OBJECTIVES</td></tr>
<tr><td></td><td colspan="7">1. To able to impart basic knowledge on cellular organization of life
2. To be able familiarize the students with the fabrication techniques used in Tissue engineering
3. To be able to identify problems and suggests remedy in the field of regenerative medicine</td></tr>
<tr><td colspan="8">COURSE OUTCOMES & GENERIC SKILLLS</td></tr>
<tr><td>No.</td><td>Course outcome</td><td>POs</td><td>Bloom’s Taxonomy</td><td>CP</td><td>CA</td><td>KP</td><td>Assessmen t Methods</td></tr>
<tr><td>CO1</td><td>Be able to understand the basic concepts of cell culture and critical components of bioreactor and tissue design</td><td>PO-1</td><td>C1-C2</td><td>1</td><td></td><td>1</td><td>T, F</td></tr>
<tr><td>CO2</td><td>Be able to explain basic principles of host response and tissue integration</td><td>PO-2</td><td>C2</td><td>3</td><td></td><td>1</td><td>T, Mid term exam</td></tr>
<tr><td>CO3</td><td>Be able to understand and judge papers, publications and lectures pertaining to the field of TE and have broad understanding of TE research</td><td>PO-1</td><td>C1, C2, C5</td><td>1</td><td></td><td>1</td><td>ASG, Pr</td></tr>
<tr><td></td><td colspan="7">(CP-Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T-Test; PR-Project; Q-Quize; ASG-Assignment; Pr-Presentaion; R-Report, F-Final Exam</td></tr>
<tr><td colspan="8">COURSE CONTENT</td></tr>
</table>

	Introduction Basic principles of Tissue Engineering Application of Tissue Engineering Challenges and ethical issues in Tissue Engineering **Basic cells culture** Cell culture, subculture, proliferation and storage Cell adhesion and migration 3D cell culture **Stem cell and differentiation** Adult Stem Cells Hematopoetic Stem Cells Embryonic Stem Cells and induced pluripotent stem cells **Extracellular matrix** Composition of extracellular matrix Matrix metalloproteinases (MMPs) and Metalloproteinase (ADAM) Decellularization **Vascularity, angiogenesis and Growth factors** Principle of cell signalling and types of receptors Growth factors delivery and gene therapy Vascularity, angiogenesis and wound healing **Scaffolds in tissue engineering** Features of scaffold Materials for scaffold formation Cell-Biomaterial Interactions **Tissue Engineering and host response**
	Transplantation immunology and grafts (organ donation), Regulating factors of Transplantation and grafts, Clinical experience. Biofabrication and biomanufacture. In Vivo Synthesis of Tissues and Organs, in Vitro Control of Tissue Development and host response and control measurement in Bone tissue engineering, Cardiac tissue engineering, Neural tissue engineering and in Connective Tissue Engineering. Animal models, Organ-in-chip, Regulation, Commercialization and Ethics.
SKILL MAPPING (CO-PO MAPPING)	

No.	Course outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basic concepts of cell culture and critical components of bioreactor and tissue design	3											
CO2	Be able to **explain** basic principles of host response and tissue integration		2										
CO3	Be able to **understand** and **judge** papers, publications and lectures pertaining to the field of TE and have broad understanding of TE research	2											

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

Justification for **CO-PO** mapping

Mapping	**Corresponding Level of matching**	**Justifications**
CO1-PO1	2	The knowledge of basic mathematics, science and bioengineering has to be applied to describe the functions of cells, scaffolds and biomolecules.
CO2-PO2	3	Knowledge of analyzing biological data, knowledge of identifying problems are instrumental to ensure better organ transplant or regenerative therapy.
CO3-PO1	3	Knowledge of updated research articles will be discussed in order to ensure applications of modern tools of tissue engineering.

TEACHING LEARNIN STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical/Tutorial/Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-Face-to Face Learning	42
Revision of the previous lecture at home	21
Preparation for the final examination	21
Formal Assessment	
Continuous assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY		
Lecture and Discussion, Co-operative and collaborative method, Problem based method		
Week	**Content**	**Assessment**
1	**Course Introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Basic Principles of Tissue Engineering	
Lecture 2	Application of Tissue Engineering	
Lecture 3	Challenges and Ethical Issues in Tissue Engineering	
2	**Basic cells culture**	
Lecture 4	Cell Culture, Subculture, Proliferation and Storage	
Lecture 5	Cell Adhesion and Migration	
Lecture 6	3D Cell Culture	
3	**Stem cell and differentiation**	
Lecture 7	Adult Stem Cells	
Lecture 8	Hematopoetic Stem Cells	
Lecture 9	Embryonic Stem Cells and Induced Pluripotent Stem Cells	
4	**Extracellular matrix**	**Midterm, Final**
Lecture 10	Composition of Extracellular Matrix	
Lecture 11	Matrix Metalloproteinases (MMPs) and Metalloproteinase (ADAM)	
Lecture 12	Decellularization	
5	**Vascularity, angiogenesis and Growth factors**	
Lecture 13	Principle of Cell Signaling and Types of Receptors	
Lecture 14	Growth Factors Delivery and Gene Therapy	
Lecture 15	Vascularity, Angiogenesis and Wound Healing	
6	**Tissue Engineering and host response**	
Lecture 16	Transplantation Immunology and Grafts (Organ Donation)	
Lecture 17	Regulating Factors of Transplantation and Grafts	
Lecture 18	Clinical Aspects	
7	**Issues in Tissue Engineering**	
Lecture 19	Animal Models	
Lecture 20	Organ-in-chip	
Lecture 21	Regulation, Commercialization and Ethics	
MIDTERM		
8	**Tissue Engineering Scaffolds & Bioreactors**	
Lecture 22	Features of Scaffold	
Lecture 23	Materials for Scaffold Formation	

Lecture 24	Bioreactors for Tissue Engineering	CT – 2, FINAL
9	**Scaffold Fabrication Techniques**	
Lecture 25	Fabrication Techniques – Fundamentals	
Lecture 26	Rapid Prototyping Techniques (Processes)	
Lecture 27	Rapid Prototyping Techniques (Attributes)	
10	**Scaffold Design and Cell-Scaffold Interactions**	
Lecture 28	Scaffold Design	
Lecture 29	Scaffold Degradation	
Lecture 30	Cell-Scaffold Interaction	
11	**Bone Tissue Engineering**	
Lecture 31	In Vivo Synthesis of Tissues and Organs	
Lecture 32	In Vitro Control of Tissue Development	
Lecture 33	Host Response and Control Measurement	
12	**Cardiac Tissue Engineering**	CT – 3, FINAL
Lecture 34	In Vivo Synthesis of Tissues and Organs	
Lecture 35	In Vitro Control of Tissue Development	
Lecture 36	Host Response and Control Measurement	
13	**Neural Tissue Engineering**	
Lecture 37	In Vivo Synthesis of Tissues and Organs	
Lecture 38	In Vitro Control of Tissue Development	
Lecture 39	Host response and control measurement	
14	**Skin Tissue Engineering**	
Lecture 40	In Vivo Synthesis of Tissues and Organs	
Lecture 41	In Vitro Control of Tissue Development	
Lecture 42	Host Response and Control Measurement	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2, C3
	Class participation	5%	CO2	C3
	Mid Term	15%	CO3	C1, C2, C3
			CO1	C1, C2

Final Exam	60%	CO2	C3
		CO3	C1, C2, C3
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor Domain, A= Affective Domain)

TEXT BOOKS
1. Principles of Tissue Engineering, by Robert Lanza, Robert Langer and Joseph P Vcanti.

REFERENCE BOOKS
1. Introduction to Tissue Engineering: Applications and Challenges (IEEE Press Series on Biomedical Engineering) 1st Edition by Ravi Birla

6.1.33 BME 412 Biomedical Engineering Design Sessional II

COURSE INFORMATION			
Course Code Course Title	: BME 412 : Biomedical Engineering Design Sessional II	Lecture Contact Hours Credit Hours	: 3.00 : 1.50

PRE-REQUISITE
Course Code: BME 318 Course Title: Biomedical Engineering Design Sessional I
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course covers the application of design tools to model prototypes and develop the individual project ideas and full completion of an individual project.
OBJECTIVE
The aim of this course is to enhance student's idea about project and develop their capabilities of project management.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** existing problems in biomedical research and the healthcare sector	C3	3, 5	1	-	1	T, Q, R
CO2	Be able to **formulate** and **implement** novel solutions to the identified problem	C4	2, 5	1	-	1, 2	T, Q, R, ASG
CO3	Be able to effectively **communicate** the problem and the results of the proposed solution through scientific writing and oral presentation	C6	3	1, 3	-	5	T, Q, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

As the follow-up course to Biomedical Engineering I Design Sessional, this course introduces the students to independent research. In the first few weeks students are teamed into groups and work to define a problem in a certain biomedical area. The problem is then vetted by the instructor(s) who help the students to generate potential solutions to the problem and create a project plan. The students then translate these potential solutions from paper to prototype with a strong emphasis of characterization and validation. Apart from problem identification, problem solving, testing and validation, students undergo rigorous training in effective technical communication (both oral and written).

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** existing problems in biomedical research and the healthcare sector			2		3							
CO2	Be able to **formulate** and **implement** novel solutions to the identified problem		2			3							
CO3	Be able to effectively **communicate** the problem and the results of the proposed solution through scientific writing and oral presentation			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Practical / Tutorial / Studio	35
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	-
Revision of the previous and (or) subsequent lecture at home	15
Preparation for final examination	10
Formal Assessment	
Continuous Assessment	1
Lab Test	1
Quiz	0.75
Viva	0.25
Total	70

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Lecture Topics	Assessment
1	Introduction, Course overview, Evaluation process, Form group	Report, Assignment, Presentation, Viva
2	Discussion on Primarily proposed projects and project scope	
3	Discussion on Selected project idea and design consideration	
4	Budget and timeline distribution, Define research gap and project scope, design requirements	
5	Model generation, usability testing, engineering analysis	
6	Primary design and simulation	
7	Finalization of design with detailed drawing and computational validation testing	
	Midterm Break	
8	Presentation on Project update	Report, Assignment, Presentation, Viva
9	Prototype fabrication review and troubleshooting	
10	Prototype verification and validation testing	
11	Draft Report Submission and Review	
12	Project Submission with complete documentation (Drawing, user manual, report and design history file)	
13	Presentation	
14	Project Showcasing	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Report	20%	CO1, CO2, CO3	C4, C5, C3
	Class Participation	20%	CO1, CO2, CO3	C4, C5, C3
Final Exam (60%)	Lab Test	20%	CO1, CO2, CO3	C4, C5, C3
	Quiz	30%	CO1, CO2, CO3	C4, C5, C3
	Viva	10%	CO1, CO2, CO3	C4, C5, C3
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

TEXT BOOKS

1. Robbinson C.J., Rehabilitation Engineering. CRC press 1995
2. Gerald E. Miller, Artificial Organs, Morgan & Claypool Publishers, 2006

REFERENCE BOOKS

1. Bronzino. Joseph, Handbook of biomedical engineering. CRC; 2 Sub editions, 1999
2. BallabioE.etal, Rehabilitation Engineering. IOS press 1993.

REFERENCE SITE

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6.1.34 BME 400 Final Year Design and Research Project

COURSE INFORMATION			
Course Code Course Title	: BME 400 : Final Year Design and Research Project	Lecture Contact Hours Credit Hours	: 12.00 : 6.00
PRE-REQUISITE			
GERM 352: Fundamentals of Research Methodology (Sessional)			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The aim of this course is to develop student's ability to design a comprehensive product/service solution of an applied biomedical engineering problem. Students will be able to apply the knowledge and skills obtained through previous courses to design a new integrated solution, validation and proper evaluation of outcomes at different stage of the project. It is also expected to enhance student's leadership ability in technical project management and be able to contribute in fourth industrial revolution.			
OBJECTIVE			
1. To formulate a research problem based on the knowledge of major subject/field of study. **2.** Design an appropriate solution technique to address the research problem. **3.** To reach the ability to evaluate the performance of proposed solution. **4.** To compare the outcomes with the latest scientific development. **5.** To assess professional, ethical and social impacts of the designed solutions. **6.** To perform research tasks using proper project management practices. **7.** To develop student's leadership ability through teamwork. **8.** To enhance student's communication skill through presentation and technical reports. **9.** Articulation of the environmental and sustainability analysis in the designed project.			

LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcomes	Corresponding PO No.	Bloom's Taxonomy	KP	CP	CA	Assessment Methods
CO1	Be able to **identify** the research gap and formulate a research problem related to biomedical engineering.	PO2	C4	3,4	1	1	IR
CO2	Be able to **design** an appropriate engineering product/service solution that meets the required technical standard and specifications.	PO3	C6	5	1	2	PR, PPr
CO3	Be proficient in **investigating** the performance of the designed engineering product/service prototype.	PO4	C5, P5	8	3		DR, ID

CO4	Be able to **evaluate** the designed product/service solution with standard scientific specification and communicate the final outcomes.	PO3	C6	5	1	2	FR, FPr, FD
CO5	Be able to **integrate** relevant engineering tools in the process of project design, development and implementation.	PO5	P4, A4	6	1	5	DR, ID, FD
CO6	Be capable in **understanding** the ethical values and professional responsibilities to the society in the different phases of the designed project.	PO8	A4	7	5	2	FR, FPr
CO7	Be able to **demonstrate** the understanding of the project impact on environmental and sustainability.	PO7	C2	7	4		PR, PPr
CO8	Be able to **assess** societal, health, safety, legal and cultural issue related to the designed project.	PO6	C5	7	4		FR, FPr
CO9	Be able to **demonstrate** leadership skills, ability to work independently and in a team through project development phases.	PO9	A5			1	FPr, FD
CO10	Be able to **develop** communication skill through technical report writing and presentation.	PO10	A2			1	FR, FPr
CO11	Be able to **conduct** financial investment analysis and estimate the project cost.	PO11	C2, P2, A3			2	PR, PPr FR, FPr
CO12	Be able to **verify** the designed problem technological, geographical and cultural adaptation in broader context.	PO12	A5			4	FR
CO13	Be **competent** in understanding of project time, stakeholder and risk management and able to prepare detail project work breakdown structure (WBS).	PO11	C3, P4, A3			2	PR, PPr FR, FPr

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile; IR- Initial Report, Proposal Report -PR, Proposal Presentation – PPr, Designed Report – DR, Initial Demonstration – ID, FR-Final Report, FPr-Final Presentation, FD- Final Demonstration

COURSE CONTENT

Every student will be required to undertake a suitable Final Year Design and Research Project during Level-4 (Term-I&II or Spring & Fall Term) in consultation with the Head of the Department and the faculty guide (or Supervisor) and submit the project or thesis at the end of Level-4 (Fall Semester) on dates announced by the institute (department).

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)

		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** the research gap and formulate a research problem related to biomedical engineering.		3										
CO2	Be able to **design** an appropriate engineering product/service solution that meets the required technical standard and specifications.			3									
CO3	Be proficient in **investigating** the performance of the designed engineering product/service prototype.				3								
CO4	Be able to **evaluate** the designed product/service solution with standard scientific specification and communicate the final outcomes.			3									
CO5	Be able to **integrate** relevant engineering tools in the process of project design, development and implementation.					3							
CO6	Be capable in **understanding** the ethical values and professional responsibilities to the society in the different phases of the designed project.								3				
CO7	Be able to **demonstrate** the understanding of the project impact on environmental and sustainability.											3	
CO8	Be able to **assess** societal, health, safety, legal and cultural issue related to the designed project.						3						
CO9	Be able to **demonstrate** leadership skills, ability to work independently and in a team through project development phases.									3			
CO10	Be able to **develop** communication skill through technical report writing and presentation.										3		
CO11	Be able to **conduct** financial investment analysis and estimate the project cost.											3	
CO12	Be able to **verify** the designed problem technological, geographical and cultural adaptation in broader context.												2
CO13	Be **competent** in understanding of project time, stakeholder and risk management and able to prepare detail project work breakdown structure (WBS).											3	

(Numerical method used for mapping which indicates 3 as high, 2 as medium and 1 as low level of matching)

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Practical / Tutorial / Studio	56
Self-Directed Learning	
Project design and background Research Work under the supervision of Supervisor	84
Project work/Simulation practice at Lab	84
Preparation of report and presentation and demonstration	40
Formal Assessment	
Demonstration	3
Presentation	3
Total	270

TEACHING METHODOLOGY

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (60%)	Initial Report (IR)	10%	CO 1	C4
	Proposal Report (PR) and Proposal Presentation (PPr)	30%	CO 2	C4
			CO 7	C2
			CO13	C3, P4, A3
			CO 11	C2, P2, A3
	Designed Report – (DR)	10%	CO3	C5, P5
			CO5	P4, A4
	Initial Demonstration (ID)	10%	CO3	C5, P5
			CO5	P4, A4
Final Report and presentation		25%	CO 4	C6

		CO 6	A4
		CO 8	C5
		CO 9	A5
		CO 10	A2
		CO 11	C2, P2, A3
		CO 12	A5
		CO 13	C3, P4, A3
Final demonstration	15%	CO 5	P4, A4
		CO 6	A4
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

Books as per the guideline of Faculty Guide or Supervisor.

6.2 Elective Course Offered

6.2.1 Group-I (Instrumentation)

6.2.1.1 BME 411 Physiological Control System

COURSE INFORMATION			
Course Code Course Title	: BME 411 : Physiological Control Systems	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
BME 201:Human physiology			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The goal of this course is to prepare students for a clear concept about control system designing of the biomedical engineering devices. Modeling a system regarding mathematical aspect as well as electromechanical environment needs a deep concept about control system. Since biomedical devices are fully concerned with our physiological behavior and its control, this subject merges the concept of engineering control system and physiological control system to provide the students a sufficient knowledge regarding the mechanism of Physiological Control System.			
OBJECTIVE			
1. Be able to apply various concepts and laws to analyze a variety of dynamic systems. 2. Be able to understand the key strategies that the body uses to regulate its function. 3. Be able to develop an understanding for control system theory as applied to human physiology. 4. Be able to apply linear control theory to model and analyze biological systems.			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** various concepts and laws to analyze a variety of dynamic systems.	C3	2	1	-	1,3	T, F
CO2	Be able to **understand** the key strategies that the body uses to regulate its function.	C2	1	1	-	1	T, F
CO3	Be able to develop an **understanding** of control system theory as applied to human physiology.	C2	1	1	-	1	MID, F
CO4	Be able to **apply** linear control theory to model and **analyze** biological systems.	C3, C4	2,3	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to physiological modelling: what is a model and why model, multi-scale organization of living organisms: cell to organ Homeostasis. Examples of physiological control systems

Tools for modelling physical systems: Review of linear systems, Laplace transform, Fourier series and Fourier transform, and system response in the time and frequency domains, transfer function, open-loop control, feedback control, and stability of systems, steady-state and transient analysis, design of PID controllers.

Physiology of cardiovascular systems: Key events in the cardiac cycle, blood pressure and flow, vascular impedance, lumped parameter models, Windkessel model of circulation, cardiac mechanics.

Physiology of Endocrine system: Enzymes and hormones, Michaelis-Menten enzyme kinetics, examples of endocrine control: glucose-insulin system, thyroid hormone system,

Physiology of Nervous System: Anatomy and physiology of nerves, action potentials, Hodgkin-Huxley model,

Physiology of Respiratory System: Respiratory mechanics, lung models.

Physiology of Musculoskeletal System: Muscle anatomy and physiology. How muscles contract. Hill model of muscle contraction, Muscle stretch reflex.

Modeling complex physiological systems: Regulation of cardiac output: Starling's law, pressure-volume curves, coupled model of cardiopulmonary system, Blood pressure regulation: Baroreceptor reflex, kidney for blood pressure regulation, Blood glucose regulation: insulin control of glucose, glucose utilization in muscle.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** various concepts and laws to analyze a variety of dynamic systems.		3										
CO2	Be able to **understand** the key strategies that the body uses to regulate its function.	3											
CO3	Be able to develop an **understanding** for control system theory as applied to human physiology.	3											
CO4	Be able to **apply** linear control theory to model and **analyze** biological systems.		3	3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21

Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to physiological modeling**	**CT – 1, Final**
Lecture 1	Course Introduction. What is a model and why model?	
Lecture 2	Multi-scale organization of living organisms: Cell to organ Homeostasis	
Lecture 3	Examples of physical control systems and physiological control systems. Difference between Physical and Physiological Control System	
2	**Tools for modeling physical systems**	
Lecture 4	Review of linear systems	
Lecture 5	Fourier series analysis	
Lecture 6	Fourier transform analysis	
3	**Tools for modeling physical systems**	
Lecture 7	Mathematical explanation of Laplace transform	
Lecture 8	System response in the time Domain and frequency domains	
Lecture 9	Open loop control and feedback control System	
4	**Transfer function analysis**	**Midterm, Final**
Lecture 10	Ordinary differential equation solving by Laplace transform and inverse Laplace transformation	
Lecture 11	Transfer function calculation of electrical system	
Lecture 12	Mechanical to electrical analogous circuit analysis	
5	**Transfer function analysis**	
Lecture 13	Electrical to mechanical analogous circuit analysis	
Lecture 14	Mechanical Translational Circuit	
Lecture 15	Development of a practical application of transfer function based on some physiological control system	
6	**Control system stability analysis**	
Lecture 16	Stability of systems	
Lecture 17	Steady-state analysis	
Lecture 18	System's transient state analysis	
7	**Control system stability analysis**	
Lecture 19	Design of a Proportional and Integral Controller	

Lecture 20	Design of a Differential controller	
Lecture 21	Design of a PID controller with physiological examples	
	Midterm	
8	**Physiology of cardiovascular systems**	**CT – 2, Final**
Lecture 22	Basic anatomy of Heart Key events in the cardiac cycle	
Lecture 23	Blood pressure and flow	
Lecture 24	Vascular impedances in heart	
9	**Physiology of cardiovascular systems**	
Lecture 25	Lumped parameter models	
Lecture 26	Windkessel model of circulation	
Lecture 27	Overall control system of cardiac mechanics	
10	**Physiology of Endocrine system**	
Lecture 28	Enzymes and hormones,	
Lecture 29	Michaelis-Menten enzyme kinetics	
Lecture 30	Glucose insulin system thyroid hormone system	
11	**Physiology of Nervous and Respiratory system**	**CT – 3, FINAL**
Lecture 31	Anatomy and physiology of nerves, action potentials,	
Lecture 32	Hodgkin-Huxley model,	
Lecture 33	Respiratory mechanics and lung models	
12	**Physiology of Musculoskeletal System:**	
Lecture 34	Muscle anatomy and physiology	
Lecture 35	How muscles contract	
Lecture 36	Hill model of muscle contraction Muscle stretch reflex.	
13	**Modeling complex physiological systems**	**FINAL**
Lecture 37	Starling's law of Cardiac output Regulation Pressure volume curves	
Lecture 38	coupled model of cardiopulmonary system	
Lecture 39	Blood pressure regulation and Baroreceptor reflex	
14	**Modeling complex physiological systems**	
Lecture 40	Kidney for blood pressure regulation,	
Lecture 41	Insulin control system of blood glucose	
Lecture 42	Glucose utilization mechanism in muscle	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C3

	Class Participation	5%	CO3	C3
	Midterm	15%	CO2	C4
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C3
			CO 4	C3, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor domain, A= Affective Domain)

TEXT BOOKS

1. M.C.K. Khoo, Physiological Control Systems: Analysis, Simulation, and Estimation, IEEE Engineering in Medicine and Biology Society, Wiley & Sons, ISBN 0-7803-3408-6.

REFERENCE BOOKS

2. R.C. Dorf and R.H. Bishop, Modern Control Systems, 12th Edition, Prentice Hall.

REFERENCE SITE

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6.2.1.2 BME 413 Virtual Bioinstrumentation

COURSE INFORMATION

Course Code Course Title	: BME 413 : Virtual Bioinstrumentation	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 207: Biomedical Instrumentation and Measurements

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

To impart adequate knowledge on Virtual Instrumentation for acquisition and analysis of signals in medical system, to educate about the basic concepts of VI, programming concepts of VI, enable them to implement VI in medical systems and design Virtual Biomedical Instruments.

OBJECTIVE

1. Be able to **understand** the concept of virtual instruments, its importance and applications of virtual instrumentation.
2. Be able to **learn** about data acquisition concept, hardware and software.
3. Be able to **design** and **test** virtual biomedical instruments.
4. Be able to **develop** virtual biomedical instruments.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods

CO1	Be able to **understand** the concept of virtual instruments, its importance and applications of virtual instrumentation	C2	1	1	-	1	T, F
CO2	Be able to **learn** about data acquisition concepts, hardware and software.	C2	1	1	-	1	T, F
CO3	Be able to **design** and **test** virtual biomedical instruments.	C4,C5	2	1	-	1,3	MID, F
CO4	Be able to **develop** virtual biomedical instruments.	C6	2,3	1,3	-	1,3	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI): Review of Virtual Instrumentation, Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram & architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming.

VI PROGRAMMING Techniques: Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input.

HARDWARE ASPECTS OF VI SYSTEM: Data Acquisition basics: , Analog input: sampling rate, multiplexing, resolution, relative accuracy, noise, Analog output, Triggers, Real-Time system integration, Digital I/O. Timing I/O, ADC, DAC; PC-Based DAQ System: PC, transducers and signal conditioners, DAQ Hardware, , DIO, Counters & timers, Multichannel analog DAQ system, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

COMMON INSTRUMENT INTERFACE: Common Instrument Interfaces for Current loop, RS 232C/Rs 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI etc, networking basics for office & industrial application, VISA and IVI.

VI ANALYSIS TOOLS: Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, Windowing and filtering.

APPLICATIONS of VI: Application of VI in process control designing of equipment like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory, Image acquisition & processing, Motion Control, VI based temperature monitor, VI based cardiac monitor, Multi-channel data acquisition using LABVIEW, ECG acquisition for long term monitoring of heart rate using VI, ECG signal processing and its importance using wavelet transform. Bio-Informatics and NI LabVIEW technology in drug discovery process. Testing of Medical Instruments.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the concept of virtual instruments, its importance and applications of virtual instrumentation	3											
CO2	Be able to **learn** about data acquisition concept, hardware and software.	3											
CO3	Be able to **design** and **test** virtual biomedical instruments.		3										
CO4	Be able to **develop** virtual biomedical instruments.		3	3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)**	**CT – 1, Final**
Lecture 1	Review of Virtual Instrumentation, Historical perspective, Need of VI, Advantages of VI, Define VI	
Lecture 2	Block diagram & architecture of VI	
Lecture 3	Data flow techniques, graphical programming in data flow, comparison with conventional programming.	
2	**HARDWARE ASPECTS OF VI SYSTEM**	
Lecture 4	Data Acquisition (DAQ) basics	
Lecture 5		
Lecture 6	Analog to Digital Converter (ADC)	
3	**HARDWARE ASPECTS OF VI SYSTEM**	
Lecture 7	Analog to Digital Converter (ADC)	
Lecture 8	Digital to Analog Converter (DAC)	
Lecture 9		
4	**HARDWARE ASPECTS OF VI SYSTEM**	**Midterm, Final**
Lecture 10	PC-Based DAQ System: PC, transducers and signal conditioners, DAQ Hardware	
Lecture 11		
Lecture 12	Multichannel analog DAQ system	
5	**HARDWARE ASPECTS OF VI SYSTEM**	
Lecture 13	DIO, DMA for DAQ	
Lecture 14	Counters, timers, interrupts for DAQ	
Lecture 15	PC Hardware structure, Software and Hardware Set up for VI.	
6	**COMMON INSTRUMENT INTERFACE**	
Lecture 16	Common Instrument Interfaces for Current loop, RS 232C/Rs 485, GPIB, System basics	
Lecture 17		
Lecture 18	Interface basics: USB, PCMCIA	
7	**COMMON INSTRUMENT INTERFACE**	
Lecture 19	Interface basics: VXI, SCXI, PXI etc	
Lecture 20	networking basics for office & industrial application, VISA and IVI.	
Lecture 21		
	Midterm	
8	**VI PROGRAMMING Techniques**	**CT – 2, Final**
Lecture 22	Programming Techniques, VIS & Sub VIS	
Lecture 23	Loops & charts, string & file input.	
Lecture 24	arrays, clusters	
9	**VI PROGRAMMING Techniques**	
Lecture 25	Graphs, waveforms	
Lecture 26	case & sequence structures	
Lecture 27	formula modes, local and global variable	
10	**VI ANALYSIS TOOLS**	
Lecture 28	Use of Analysis tools: Fourier transforms, power spectrum, correlation methods, Windowing and filtering.	
Lecture 29	Use of Analysis tools: power spectrum, correlation methods	

Lecture 30	Use of Analysis tools: Windowing and filtering.	
11	**APPLICATIONS of VI**	**CT – 3, FINAL**
Lecture 31	Application of VI in process control designing of equipments like oscilloscope, Digital multimeter	
Lecture 32	Design of digital Voltmeters with transducer input Virtual Laboratory	
Lecture 33	Web based Laboratory	
12	**APPLICATIONS of VI**	
Lecture 34	Image acquisition & processing	
Lecture 35	Motion Control	
Lecture 36	VI based temperature monitor	
13	**APPLICATIONS of VI**	**FINAL**
Lecture 37	VI based cardiac monitor	
Lecture 38	Multi-channel data acquisition using LABVIEW	
Lecture 39	ECG acquisition for long term monitoring of heart rate using VI	
14	**APPLICATIONS of VI**	
Lecture 40	ECG signal processing and its importance using wavelet transform.	
Lecture 41	Bio-Informatics and NI labVIEW technology in drug discovery process.	
Lecture 42	Testing of Medical Instruments.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C4,C5
	Class Participation	5%	CO3	C4,C5
	Midterm	15%	CO2	C2
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C4,C5
			CO 4	C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor domain, A= Affective Domain)

TEXT BOOKS

1. Olansen Jon B. and Rosow Eric, "Virtual Bio-Instrumentation Biomedical, Clinical, and Healthcare Applications in LabVIEW", National instrument Virtual instrument series
2. Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, Fourth edition 2006

REFERENCE BOOKS

3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.
4. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.

REFERENCE SITE

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6.2.1.3 BME 415 Biophotonics

COURSE INFORMATION

Course Code	: BME 415	Lecture Contact Hours	: 3.00
Course Title	: Biophotonics	Credit Hours	: 3.00

PRE-REQUISITE

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course is designed for delivering the knowledge about the magical properties of photobiology and their wide applications in different fields of biomedical engineering.

OBJECTIVE

1. To deliver the fundamental principles of biophotonics
2. To connect the students learning about the wide application of different optical devices in different fields of biomedical engineering.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the fundamental knowledge about the photobiology	C2	1	1	-	1,3	T, MID
CO2	Be able to **familiarize** with different optical devices in biomedical engineering domain	C2	1	1,3	-	1,3	MID, F
CO3	Be able to **learn** about the working principles of different optical devices	C2	1	1,2	-	1,2	MID, F
CO4	Be able to **apply** the knowledge of biophotonics in different medical applications	C3	1	1,3	-	1,2	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Biophotonics: Photonics in medical applications, properties of light and matter, light-matter interactions, interaction of light with cells, interaction of light with tissues; **Laser Technology**: Principles of Lasers, Laser-tissue Interaction, Lasers for biophotonics, laser safety; **Optical Fiber and Light:** Optical fiber construction, principles of light propagation in optical fiber, losses and dispersion in fiber optics. **Instrumentation in Photonics**: Instrumentation for absorption, Scattering, and Emission, high pressure arc lamp, LEDs, Optical detectors; **Photonics**

in Bioimaging: An overview of optical imaging, Simple and compound microscope, Fluorescence Microscopy, Fluorescence Resonance Energy Transfer (FRET) Imaging, Fluorescence Lifetime Imaging Microscopy (FLIM), Raman Scattering Microscopy.

Medical application of lasers: Thermal interaction between laser and Tissue, Application of Lasers in therapy and diagnosis, Surgical Applications of Lasers, Lasers in Dentistry and urology, Laser Tissue Contouring and Restructuring, Tissue welding, Laser Tissue Regeneration, Laser Tweezers and Laser Scissors; **Endoscopy:** Angioscope, Videoscopy, Fluorescence endoscopy, Endoscopic therapy; **Optical Biosensors:** Principles of Optical Biosensing, Optical Transduction, Fluorescence Sensing, Fiber-Optic Biosensors, Evanescent Wave Biosensors, Surface Plasmon Resonance Biosensors; **Microarray Technology:** DNA Microarray Technology, cell and tissue microarray technology, **Light-Activated Therapy:** Basic mechanism of Photodynamic Therapy, Applications of Photodynamic Therapy, Two-Photon Photodynamic Therapy.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the fundamental knowledge about the photobiology	2											
CO2	Be **familiarized** with different optical devices in biomedical engineering domain	3											
CO3	Be able to **learn** about the working principles of different optical devices	3											
CO4	Be able to **apply** the knowledge of biophotonics in different medical applications	2											

Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Introduction to Biophotonics**	**CT – 1, Final**
Lecture 1	Photonics in medical applications, properties of light and matter	
Lecture 2	light-matter interactions	
Lecture 3	Interaction of light with cells, interaction of light with tissues	
2	**Laser Physics**	
Lecture 4	Principles of Lasers, ,	
Lecture 5	Laser-tissue Interaction	
Lecture 6	Lasers for biophotonics, laser safety	
3	**Optical Fiber and Light**	
Lecture 7	Optical fiber construction,	
Lecture 8	Principles of light propagation in optical fiber	
Lecture 9	Losses and dispersion in fiber optics	
4	**Instrumentation in Photonics**	**Midterm, Final**
Lecture 10	Instrumentation for absorption	
Lecture 11	Instrumentation for Scattering	
Lecture 12	Instrumentation for Emission	
5	**Instrumentation in Photonics**	
Lecture 13	high pressure arc lamp	
Lecture 14	LEDs, Optical detectors	
Lecture 15		
6	**Photonics in Bioimaging**	
Lecture 16	An overview of optical imaging	
Lecture 17	Simple and compound microscope	
Lecture 18	Fluorescence Microscopy	
7	**Photonics in Bioimaging**	
Lecture 19	Fluorescence Resonance Energy Transfer (FRET) Imaging	
Lecture 20	Fluorescence Lifetime Imaging Microscopy (FLIM)	
Lecture 21	Raman Scattering Microscopy	
	Midterm Break	
8	**Medical application of lasers**	**CT – 2, Final**
Lecture 22	Thermal interaction between laser and Tissue	
Lecture 23	Application of Lasers in therapy	
Lecture 24	Application of Lasers in diagnosis	
9	**Medical application of lasers**	
Lecture 25	Surgical Applications of Lasers	
Lecture 26	Lasers in Dentistry and urology	
Lecture 27	Laser Tissue Contouring and Restructuring	
10	**Medical application of lasers**	
Lecture 28	Tissue welding, Laser Tissue Regeneration	
Lecture 29	Laser Tweezers	
Lecture 30	Laser Scissors	
11	**Endoscopy**	
Lecture 31	Angioscope, Videoscopy	
Lecture 32	Fluorescence endoscopy	

Lecture 33	Endoscopic therapy	**CT – 3, FINAL**
12	**Optical Biosensors**	
Lecture 34	Principles of Optical Biosensing, Optical Transduction	
Lecture 35	Fluorescence Sensing, Fiber-Optic Biosensors	
Lecture 36	Evanescent Wave Biosensors, Surface Plasmon Resonance Biosensors	
13	**Microarray Technology**	**FINAL**
Lecture 37	DNA Microarray Technology	
Lecture 38	Cell and tissue microarray technology	
Lecture 39		
14	**Light-Activated Therapy**	
Lecture 40	Basic mechanism of Photodynamic Therapy	
Lecture 41	Applications of Photodynamic Therapy	
Lecture 42	Two-Photon Photodynamic Therapy	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C1
Final Exam		60%	CO 1	C2
			CO 2	C2
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Introduction to Biophotonics", Paras N. Prasad , A. John Wiley and Sons, Inc. Publications, 2003.
2. Laser-Tissue Interaction Fundamentals and Applications, Markolf H.Niemz, Springer, 2007

REFERENCE BOOKS

3. Lasers and Optical Fibers in Medicine, Abraham Katzir, Academic Press Inc.

REFERENCE SITE

6.2.1.4 BME 417 Equipment in Radiology and Radiotherapy

COURSE INFORMATION			
Course Code Course Title	: BME 417 : Equipment in Radiology and Radiotherapy	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

PHY 125: Waves and Oscillations, Optics and Modern Physics

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course is designed to give the basic concepts of Radiation physics, Radiation measurement instruments and Radiotherapy equipment.

OBJECTIVE

1. Be able to understand the basics of Radiation physics
2. Be able to understand the principles of Radiation measuring instruments
3. Be able to learn the principles of Radiotherapy equipment.
4. Be able to analyze the Quality Assurance techniques of Radiotherapy Equipment

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basics of Radiation physics	C2	1	1	-	1	T, F
CO2	Be able to **understand** the principles of Radiation measuring instruments	C2	1	1	-	1	T, F
CO3	Be able to **learn** the principles of Radiotherapy equipment.	C3	1	1	-	1,3	MID, F
CO4	Be able to **analyze** the Quality Assurance techniques of Radiotherapy Equipment	C4	2,3	1,3	-	1,3	T, F
CO5	Be able to **critically review** recent articles from the scientific literature and **identify** areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

BASIC RADIATION PHYSICS: Introduction to Radiology and radiotherapy, Overview of atomic and nuclear structure, Electron interactions, Photon interactions

DOSIMETRIC PRINCIPLES, QUANTITIES AND UNITS: Photon fluence and energy fluence, KERMA, CEMA, absorbed dose, stopping power, Relationships between various dosimetric quantities, Cavity theory

RADIATION DOSIMETERS: Properties of dosimeters, Ionization chamber dosimetry systems, Film dosimetry, Luminescence dosimetry, Semiconductor dosimetry, Other dosimetry systems, primary standards

RADIATION MONITORING INSTRUMENTS: Operational quantities for Radiation monitoring, Ionization chambers, Proportional counters, Neutron area survey meters, Geiger–Müller counters , Scintillator detectors, Semiconductor detectors, Commonly available features of area survey meters, Calibration of survey meters, Properties of survey meters

RADIATION MONITORING INSTRUMENTS: Individual monitoring: Film badge, Thermoluminescence dosimetry badge**,** Radiophotoluminescent glass dosimetry systems, Optically stimulated luminescence systems, Direct reading personal monitors, Calibration of personal dosimeters, Properties of personal monitors.

TREATMENT MACHINES FOR EXTERNAL BEAM RADIOTHERAPY: X-RAY beams and X-RAY units, GAMMA-RAY beams and GAMMA RAY units, Particle accelerators: Betatron, Cyclotron, Microtron, LINAC generations , Safety of LINAC installations, Linac treatment head, Production of clinical photon beams in a LINAC, Beam collimation, Components of modern LINACs , Configuration of modern LINACs, Radiofrequency power generation system, Microwave power transmission, Accelerating waveguide, Injection system , Auxiliary system , Electron beam transport, Production of clinical electron beams in a LINAC, Dose monitoring system, Radiotherapy with protons, neutrons and Heavy ions, Introduction of Simulator, Description of the Standard Simulator, Special Features , Simulators and Computed Tomography simulators

QUALITY ASSURANCE OF EXTERNAL BEAM RADIOTHERAPY: Quality assurance in radiotherapy, Quality control, Quality standards, Need for quality assurance in radiotherapy, Requirements on accuracy in radiotherapy, Managing a quality assurance programme, quality assurance programme for equipment, Treatment delivery, and Quality audit.

BRACHYTHERAPY-PHYSICAL AND CLINICAL ASPECTS: Introduction and photon source characteristics, Clinical use and dosimetry systems**,** Dose distributions around sources, Dose calculation procedures, Commissioning of brachytherapy computer, Treatment planning systems, Source commissioning, Quality Assurance.

SPECIAL PROCEDURES AND TECHNIQUES IN RADIOTHERAPY: Image guided radiotherapy, Overview of Stereotactic irradiation, Total body irradiation, Total skin electron irradiation, Intraoperative radiotherapy, Endocavitary Rectal irradiation, Conformal radiotherapy

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basics of Radiation physics	3											
CO2	Be able to **understand** the principles of Radiation measuring instruments	3											
CO3	Be able to **learn** the principles of Radiotherapy equipment.	3											
CO4	Be able to **analyze** the Quality Assurance techniques of Radiotherapy Equipment		3	1									
CO5	Be able to **critically review** recent articles from the scientific literature and **identify** areas of research opportunities.			3						3			2

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Basic radiation physics**	**CT – 1, Final**
Lecture 1	Introduction to Radiology and radiotherapy, Overview of atomic and nuclear structure, Classification of radiation	
Lecture 2	Electron interactions	
Lecture 3	Photon interactions	
2	**Dosimetric principles, quantities and units**	
Lecture 4	Photon fluence and energy fluence, KERMA, CEMA, absorbed dose, stopping power	
Lecture 5	Relationships between various dosimetric quantities	
Lecture 6	Cavity theory	
3	**Radiation Dosimeters**	
Lecture 7	Properties of dosimeters, Ionization chamber dosimetry systems	
Lecture 8	Film dosimetry, Luminescence dosimetry	
Lecture 9	Semiconductor dosimetry, Other dosimetry systems, primary standards	
4	**Radiation monitoring instruments**	**Midterm, Final**
Lecture 10	Operational quantities for Radiation monitoring, Ionization chambers	
Lecture 11	Proportional counters, Neutron area survey meters,	
Lecture 12	Geiger–Müller counters	
5	**Radiation monitoring instruments**	
Lecture 13	Scintillator detectors, Semiconductor detectors	
Lecture 14	Commonly available features of area survey meters, Properties of survey meters	

Lecture 15	Calibration of survey meters	
6	**Radiation monitoring instruments**	
Lecture 16	Individual monitoring: Film badge, Thermoluminescence dosimetry badge	
Lecture 17	Radiophotoluminescent glass dosimetry systems, Optically stimulated luminescence systems,	
Lecture 18	Direct reading personal monitors, Calibration of personal dosimeters, Properties of personal monitors	
7	**Treatment machines for External Beam Radiotherapy**	
Lecture 19	X-RAY beams and X-RAY units, GAMMA-RAY beams and GAMMA RAY units	
Lecture 20	Particle accelerators: Betatron, Cyclotron, Microtron	
Lecture 21		
	Midterm	
8	**Treatment machines for External Beam Radiotherapy**	**CT – 2, Final**
Lecture 22	LINAC principle, LINAC treatment head, Safety of LINAC installations	
Lecture 23	Production of clinical photon beams in a LINAC, Beam collimation	
Lecture 24	Components of modern LINACs , Configuration of modern LINACs	
9	**Treatment machines for External Beam Radiotherapy**	
Lecture 25	Radiofrequency power generation system, Microwave power transmission , Accelerating waveguide	
Lecture 26	Injection system , Auxiliary system , Electron beam transport	
Lecture 27	Production of clinical electron beams in a LINAC, Dose monitoring system	
10	**Treatment machines for External Beam Radiotherapy**	
Lecture 28	Radiotherapy with protons, neutrons and Heavy ions	
Lecture 29	Introduction of Simulator, Description of the Standard Simulator, Special Features	
Lecture 30	Simulators and Computed Tomography simulators	
11	**QUALITY ASSURANCE of External Beam Radiotherapy**	**CT – 3, FINAL**
Lecture 31	Quality assurance in radiotherapy, Quality control, Quality standards, Need for quality assurance in radiotherapy, Requirements on accuracy in radiotherapy	
Lecture 32	Managing a quality assurance programme, quality assurance programme for equipment	
Lecture 33	Treatment delivery, Quality audit	
12	**Brachytherapy: Physical and Clinical aspects**	
Lecture 34	Introduction and photon source characteristics	
Lecture 35	Clinical use and dosimetry systems	
Lecture 36	Dose distributions around sources, Dose calculation procedures	
13	**Brachytherapy: Physical and Clinical aspects**	**FINAL**
Lecture 37	Commissioning of brachytherapy computer Treatment planning systems	
Lecture 38	Source commissioning, Quality Assurance	

Lecture 39	Brachytherapy versus External Beam Radiotherapy	
14	**Special procedures and techniques in radiotherapy + Radiation Protection & Safety**	
Lecture 40	Image guided radiotherapy	
Lecture 41	Overview of Stereotactic irradiation, Total body irradiation, Total skin electron irradiation, Intraoperative radiotherapy, Endocavitary Rectal irradiation, Conformal radiotherapy	
Lecture 42	Radiation protection and safety in radiotherapy: Overview	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C4
Final Exam		60%	CO 1	C2
			CO 2	C2
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P= Psychomotor domain, A= Affective Domain)

TEXT BOOKS

1. E.B. Podgorsak, Radiation Oncology Physics: A Handbook for Teachers and Students, IAEA 2005.

REFERENCE BOOKS

2. Faiz M. Khan, John P. Gibbons, The Physics of Radiation Therapy, 5th Edition, Lippincott Williams and Wilkins.

REFERENCE SITE

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6.2.2 Group-II (Regenerative Medicine)

6.2.2.1 BME 419 Drug Development and Delivery System

COURSE INFORMATION			
Course Code Course Title	: BME 419 : Drug development and delivery systems	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 203: Biochemistry
BME 303: Biomaterials

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to prepare students for an academic and industrial career in pharmaceutics and/or drug delivery. Key concepts in medicinal chemistry is discussed and the pipeline for drug development starting from computational analysis all the way through to clinical trials and commercialization is covered. Drug delivery and targeting methods is also explored in sufficient details.

OBJECTIVE

1. Bo be able to **understand** drug design based on functions and activity
2. Be able **optimize** and test drugs for safety, efficacy, and biological activity
3. Be able to **understand** and appreciate the levels of clinical trial and testing for drug commercialization
4. Be able **design and develop** drug delivery systems and targeted drug delivery methods

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Bo be able to **understand** drug design based on functions and activity	C2	1	1	-	1	T, MID, F
CO2	Be able to **optimize** and test drugs for safety, efficacy, and biological activity	C4, C5	3,6	3	1	1,3	T, MID, F
CO3	Be able to **understand** and appreciate the levels of clinical trial and testing for drug commercialization	C2	1	-	1	-	T,F
CO4	Be able to **design and develop** drug delivery systems and targeted drug delivery methods	C4, C6	2	1	1	1,3	T, F
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The course covers the following modules: drug design, drug development, drug toxicity, selectivity, structure activity relationships. drug dosage, drug safety and standards, clinical trials and product validation, drug delivery methods, targeted drug delivery, chemotherapy and cancer therapeutics.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Bo be able to **understand** drug design based on functions and activity	3											
CO2	Be able to **optimize** and test drugs for safety, efficacy, and biological activity			3			1						
CO3	Be able to **understand** and appreciate the levels of clinical trial and testing for drug commercialization	3											
CO4	Be able to **design and develop** drug delivery systems and targeted drug delivery methods		3										
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			12

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Motivation and course introduction**	
Lecture 1	Motivation course	
Lecture 2	Introduction to drug development	
Lecture 3	Drug discovery	
2	**Drug development**	

Lecture 4	Drug development methods and protocol	**CT – 1 and Midterm, Final**
Lecture 5	Target identification, bioinformatics and biological databases	
Lecture 6	Bioinformatics and biological databases	
3	**Drug development continued**	
Lecture 7	Computer aided drug design	
Lecture 8	Lead generation strategies	
Lecture 9	Lead optimization strategies	
4	**Pharmacology**	
Lecture 10	Pharmacodynamics and Pharmacokinetics	
Lecture 11	Biological activity of drugs	
Lecture 12	Biological activity of drugs	
5	**Drug metabolism**	**Midterm, Final**
Lecture 13	Introduction to medicinal chemistry	
Lecture 14	Enzyme kinetics	
Lecture 15	Structure Activity Relationships	
6	**Drug metabolism continued**	
Lecture 16	Structure Activity Relationships	
Lecture 17	Drug action mechanism	
Lecture 18	Drug action stability	
7	**Selective toxicity of drugs**	
Lecture 19	Toxicology assessment of novel drugs,	
Lecture 20	In-vitro and in-vivo toxicity (animal models)	
Lecture 21	Drug dosage and toxicity, mechanism of toxicity	
MIDTERM		
8	**Drug safety and testing**	**CT – 2, FINAL**
Lecture 22	Drug safety protocols and regulatory standards around the world	
Lecture 23	In-vitro testing	
Lecture 24	In-vivo testing	
9	**Clinical trials and commercialization**	
Lecture 25	Pre-clinical studies	
Lecture 26	Multiphase clinical trials	
Lecture 27	Drug manufacturing process and commercialization	
10	**Drug delivery techniques 1**	
Lecture 28	Administration of drugs - oral	
Lecture 29	Administration of drugs - intravenous, subcutaneous	
Lecture 30	Administration of drugs – other methods	
11	**Drug delivery techniques 2**	**CT – 3, FINAL**
Lecture 31	Surface modification and chemistry used in drug delivery	
Lecture 32	Polymeric drug delivery methods	
Lecture 33	Liposomal drug delivery	
12	**Drug delivery techniques 3**	
Lecture 34	Introduction to gene therapy	
Lecture 35	Gene therapy drug delivery	
Lecture 36	Immunotherapy - Car-T cells and molecular antibody therapy	
13	**Drug delivery techniques 4**	

Lecture 37	Drug carriers and molecular carriers	**FINAL**
Lecture 38	Nanoparticle as the drug carrier	
Lecture 39	Stability of nanoparticles as drug carrier	
14	**Targeted drug delivery for cancer**	
Lecture 40	Chemotherapy and cancer therapeutics	
Lecture 41	Nanoparticle mediated cancer therapy	
Lecture 42	Nanoparticle mediated cancer therapy	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4	C2, C4, C5, C6
	Class Participation	5%	CO1, CO2, CO3, CO4	C2, C4, C5, C6
	Midterm	15%	CO1, CO2	C2, C4, C5
Final Exam		60%	CO 1	C2
			CO 2	C4, C5
			CO 3	C2
			CO 4	C4, C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Recent advances in novel drug carrier systems, Ali Demer Sezer, 2012, InTech Open
2. Introduction to medicinal chemistry, Graham L. Patrick, 1995, Oxford University Press

REFERENCE BOOKS

1. Drug discovery and development, Izet M. Kapetanovic, 2011, InTech Open
2. Basic principles of drug discovery and development, Benjamin E. Blass, 2015, Elsevier
3. Computational drug design, David C. Young, 2009, Wiley Online Books

REFERENCE SITE

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6.2.2.2 BME 421 Nanotechnology in Biomedicine

COURSE INFORMATION

Course Code Course Title	: BME 421 : Nanotechnology in Biomedicine	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 303: Biomaterials

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to introduce students to the world of nanotechnology and its application in biology and medicine. Topics include solid state theory in physics and the fundamentals of nano sciences, optical, mechanical and electrical properties of nanoparticles. Fabrication, characterization and applications of nanotechnology in MEMS, NEMS is also covered

OBJECTIVE

1. Be able to **understand** the fundamentals of nanotechnology
2. Be able to **synthesize** nanoparticles and nanosystems
3. Be able to **characterize** the properties of nanoparticles and nanosystems
4. Be able to **design** and **develop** nanosystems for applications in biology

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the fundamentals of nanotechnology	C2	1	1	-	1	T, MID
CO2	Be able to **synthesize** nanoparticles and nanosystems	C3	1,2	1	1	1	T, MID, F
CO3	Be able to **characterize** the properties of nanoparticles and nanosystems	C5	1.2	1	1	2	T, MID, F
CO4	Be able to **design** and **develop** nanosystems for applications in biology	C4, C6	3,6	1	1	2	T, MID, F
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The course covers the following modules: solid state physics, properties of nano particles (optical, electrical, mechanical), quantum dots, carbon nanotubes, preparation and fabrication of nanoparticles, characterization of nanoparticles, applications of nanotechnology in medicine, MEMs, NEMs, nanoparticle mediated drug delivery, lab-on-chip and microfluidics technologies used in therapy, diagnostics and prognostics..

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the fundamentals of nanotechnology	3											
CO2	Be able to **synthesize** nanoparticles and nanosystems	3	3										
CO3	Be able to **characterize** the properties of nanoparticles and nanosystems	3	3										
CO4	Be able to **design** and **develop** nanosystems for applications in biology			3			1						
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Motivation and course introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Introduction to nanomaterials and nanotechnology	
Lecture 2	Top-down and bottom up approaches to synthesizing nanoparticles	
Lecture 3	Overview of quantum mechanics in nanotechnology	
2	**Solid-state physics**	
Lecture 4	Solid state physics fundamentals in nanoscience	
Lecture 5	Thermal consideration in nanoparticle development	
Lecture 6	Quantum consideration in nanoparticle development	
3	**Properties of nanoparticles**	
Lecture 7	Size dependence of nanoparticles	

Lecture 8	Surface and bulk properties of nanoparticles	
Lecture 9	Nanoscale interactions	
4	**Properties of nanoparticles**	
Lecture 10	Mechanical properties of nanomaterials	
Lecture 11	Electrical properties of nanoparticles – conductivity and resistivity	
Lecture 12	Classification of nanomaterials based on conductivity	
5	**Properties of nanoparticles**	**Midterm, Final**
Lecture 13	Optical properties of nanoparticles	
Lecture 14	Thermal properties of nanomaterials	
Lecture 15	Magnetic nanoparticles and their properties	
6	**Characterization of nanosystems**	
Lecture 16	X-Ray diffraction, X-ray absorption spectroscopy, NMR	
Lecture 17	Plasmonic nanoparticles, SERS and RAMAN spectroscopy	
Lecture 18	Electron microscopy, Dynamic light scattering, photoelectric emission scattering	
7	**Fabrication of nanosystems**	
Lecture 19	Lithography techniques for fabricating nanosystems	
Lecture 20	Procedures used in lithography	
Lecture 21	Procedures used in lithography	
MIDTERM		
8	**MEMS and NEMS**	**CT – 2, FINAL**
Lecture 22	Introduction to MEMS and NEMS technology	
Lecture 23	Microfluidics applications of MEME and NEMS	
Lecture 24	Etching and bonding in MEMS/NEMS	
9	**Synthesis and preparation of nanomaterials**	
Lecture 25	Sol-gel method, Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD)	
Lecture 26	Bonding, characteristics of Carbon nanoparticles – Fullerene and nanotubes	
Lecture 27	Synthesis and properties of Carbon nanoparticles – Fullerene and nanotubes	
10	**Nanowires and Quantum dots**	
Lecture 28	Nanowires, nanowells, nanocomposites	
Lecture 29	Quantum dots – physics, structure and size dependence	
Lecture 30	Quantum dots – therapeutic and detection of diseases	
11	**Molecular Devices**	**CT – 3, FINAL**
Lecture 31	DNA nanotechnology, molecular and supramolecular switches	
Lecture 32	Protein, glyco, lipid nanotechnology	
Lecture 33	Biobots and bionanomachines	
12	**Nanosensors**	
Lecture 34	Nanosensors in cancer therapy	
Lecture 35	Nanosensors in cancer diagnostics	
Lecture 36	Nanosensors in point of care diagnostics	
13	**Nanotechnology applications**	
Lecture 37	Nanosensors in lab-on-chip technologies	

Lecture 38	Nanotechnology in tissue engineering	**FINAL**
Lecture 39	Nanotechnology in drug targeting	
14	**Nanotechnology applications**	
Lecture 40	Cellular uptake and interaction of nanomaterials	
Lecture 41	In-vitro studies, nanotoxicology	
Lecture 42	Revision	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4	C2, C3
	Class Participation/Assignment	5%	CO1, CO2, CO3, CO4	C2, C3, C4, C5, C6
	Midterm	15%	CO1, CO2	C1, C2
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C5
			CO 4	C4, C6
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Di Ventra, Massimiliano; Evoy, Stephane; Heflin, James R., Introduction to Nanoscale Science and Technology, Springer publications, 2004 (UNITS I, II, III & IV)
2. VinodLabhasetwar, Diandra L. Leslie-Pelecky, Biomedical Applications Of Nanotechnology, Wiley-Interscience A John Wiley & Son, Inc., Publication, 2007 (UNIT V)

REFERENCE BOOKS:

1. Chattopadhyay, Introduction to Nanoscience and Naotechnology, PHI, 2009
2. B.k. Parthasarathy, NanoscienceAnd Nanotechnology, Gyan Books, 2007
3. Vicki H. Grassian, Nanoscience And Nanotechnology: Environmental And Health Impacts (Hardcover - 2008), John Wiley & Sons
4. T. Pradeep, Nano – The essentials, McGraw-Hill publishers, 2008
5. Bhushan, Bharat (Ed.), Springer Handbook of Nanotechnology, Springer publications, 2nd rev. and extended ed., 2007
6. Tuan Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, Jan 2007

REFERENCE SITE

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6.2.2.3 BME 423 Artificial Organ Development

COURSE INFORMATION			
Course Code Course Title	: BME 423 : Artificial Organ Development	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 303 – Biomaterials; BME 203 – Biofluid Mechanics and Heat Transfer; BME 407 – Rehabilitation Engineering

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The course covers the following modules: introduction to artificial organs, rheological properties of blood, blood viscosity variation, artificial kidney, hemodialyzers, artificial heart-lung machine, audiometry, and hearing aids.

OBJECTIVE

1. To identify and analyze the factors and parameters influencing blood flow
2. To explain and examine the mechanism of dialysis of kidney, gas exchange in lungs, and sound conduction in ear
3. To design and develop artificial kidney, artificial heart-lung machine, and hearing aids

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **apply** the factors and parameters influencing blood flow	C3	3	-	-	1	T, MID, F
CO2	Be able to **understand** the mechanism of dialysis of kidney, gas exchange in lungs, and sound conduction in ear	C2	1	-	-	3	T, MID, F
CO3	Be able to **analyze** the working mechanism of artificial kidney, artificial heart-lung machine, and hearing aids	C4	3	-	-	4	T, F
CO4	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Introduction to Artificial Organs: Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction.

Rheological properties of blood, blood viscosity variation: effect of shear rate, hematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow.

Artificial Kidney: Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney and middle molecule hypothesis.

Hemodialysers: flat plate type, coil type and hollow fiber. Analysis of mass transfer in dialyers (cross current & cocurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients.

Artificial Heart-lung Machine: Brief of lungs gaseous exchange / transport, artificial heart-lung devices.

Oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators. Liver support system, artificial pancreas, blood and skin.

Audiometry: air conduction, bone conduction, masking, functional diagram of an audiometer.

Hearing aids: different types, receiver amplifiers. Opthalmoscope, retinoscope, I.A.B.P principle and application.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **apply** the factors and parameters influencing blood flow			3									
CO2	Be able to **understand** the mechanism of dialysis of kidney, gas exchange in lungs, and sound conduction in ear	3											
CO3	Be able to **analyze** the working mechanism of artificial kidney, artificial heart-lung machine, and hearing aids			3									
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			2

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Motivation and course introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Motivation course	
Lecture 2	Introduction to Artificial Organs	
Lecture 3	Biomaterials used and the body's response to them	
2	**Properties of blood**	
Lecture 4	Rheological properties of blood	
Lecture 5	Blood viscosity variation: effect of shear rate and hematocrit	
Lecture 6	Blood viscosity variation: effect of temperature and protein contents	
3	**Properties of blood continued**	
Lecture 7	Casson equation	
Lecture 8	flow properties of blood through the blood vessels	
Lecture 9	problems associated with extracorporeal blood flow	

4	**Artificial Kidney**	**Midterm, Final**
Lecture 10	Brief of kidney filtration	
Lecture 11	basic methods of artificial waste removal and hemodialysis	
Lecture 12	equation for artificial kidney and middle molecule hypothesis	
5	**Hemodialysers**	
Lecture 13	Flat plate type	
Lecture 14	Coil type	
Lecture 15	Hollow fiber type	
6	**Hemodialysers continued**	
Lecture 16	Analysis of mass transfer in dialysers: cross current flow	
Lecture 17	Analysis of mass transfer in dialysers: concurrent flow	
Lecture 18	regeneration of dialysate	
7	**Hemodialysers**	
Lecture 19	membrane configuration	
Lecture 20	wearable artificial kidney machine	
Lecture 21	separation of antigens from blood in ESRD patients	
MIDTERM		
8	**Artificial Heart-lung Machine**	**CT – 2, FINAL**
Lecture 22	Brief of lungs gaseous exchange / transport	
Lecture 23	Artificial heart-lung devices	
Lecture 24	Artificial heart-lung devices	
9	**Oxygenators**	
Lecture 25	Artificial heart-lung devices	
Lecture 26	Bubble oxygenators	
Lecture 27	Film oxygenators	
10	**Oxygenators continued**	
Lecture 28	Membrane oxygenators	
Lecture 29	Membrane oxygenators	
Lecture 30	Gas flow rate and area for membrane oxygenators	
11	**Artificial liver, pancreas, blood, and skin**	**CT – 3, FINAL**
Lecture 31	Liver support system	
Lecture 32	Artificial pancreas	
Lecture 33	Artificial blood and skin	
12	**Audiometry**	
Lecture 34	Air conduction and bone conduction	
Lecture 35	Masking	
Lecture 36	Functional diagram of an audiometer	
13	**Hearing aids**	
Lecture 37	Types of hearing aids	
Lecture 38	Types of hearing aids	
Lecture 39	Receiver amplifiers	
14	**Optical diagnosis and I.A.B.P.**	
Lecture 40	Opthalmoscope and Retinoscope	
Lecture 41	I.A.B.P principle and application	
Lecture 42	I.A.B.P principle and application	
FINAL EXAMINATION		

ASSESSMENT STRATEGY				
Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3	C2. C3, C4
	Class Participation	5%	CO3	C4
	Midterm	15%	CO1, CO2	C2, C3
Final Exam		60%	CO 1	C3
			CO 2	C2
			CO 3	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Artificial Organs (Volume 4 of Synthesis lectures on biomedical engineering) by Gerald E. Miller, Morgan & Claypool Publishers, 2006.
2. Biomedical Engineering and Design Handbook Volume 2 by Myer Kutz, the McGraw-Hill Companies, Inc, 2009.

REFERENCE BOOKS

3. Biomedical Engineering Handbook volume 2 by Joseph D. Bronzino, Springer Science & Business Media, 2000.

REFERENCE SITE

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6.2.2.4 BME 425 Bioinformatics

COURSE INFORMATION			
Course Code Course Title	: BME 425 : Bioinformatics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 301: Statistics and Numerical methods for Biomedical Engineers

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course introduces students to basic concepts of molecular biology including the central dogma of biology, DNA replication, transcription, translation, and nucleic acid and protein analytical tools. Introduction to basic bioinformatics algorithms for pair-wise and multiple sequence alignment, statistical significance testing, Bayesian theorem, predictive modeling and phylogenetic analysis is covered. Students will also learn to use currently existing database retrieval systems and online bioinformatics tools through in-class exercises and assignments.

OBJECTIVE

1. Be able to understand the basic concepts of molecular biology and biological sequences that are routinely used in bioinformatics
2. Be able to recreate and construct basic search and alignment algorithms used in bioinformatics
3. Be able to apply and use currently existing sequence databases and bioinformatics tools
4. Be able to analyze and conduct phylogenetic based algorithm in ancestral studies

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basic concepts of molecular biology and biological sequences that are routinely used in bioinformatics	C2	1	-	-	1	T, MID
CO2	Be able to **recreate** and **construct** basic search and alignment algorithms used in bioinformatics	C6	2,4	1	1	1, 2	T, MID, F
CO3	Be able to **apply** and use currently existing sequence databases and bioinformatics tools	C3	1,2	-	1	2	ASG
CO4	Be able to **analyze** and conduct phylogenetic based algorithm in ancestral studies	C4	1	1	1	2	T,F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

The course covers the following modules: molecular genetics, central dogma, gene and sequence analysis techniques, gene sequencing, BLAST, sequence alignment, protein structure visualization, structure analysis, multiple sequence analysis techniques, phylogenetic analysis, online database and bioinformatic tools.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basic concepts of molecular biology and biological sequences that are routinely used in bioinformatics	3											
CO2	Be able to **recreate** and **construct** basic search and alignment algorithms used in bioinformatics		3		2								
CO3	Be able to **apply** and use currently existing sequence databases and bioinformatics tools	3	2										
CO4	Be able to **analyze** and conduct phylogenetic based algorithm in ancestral studies	3	3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Motivation and course introduction**	**CT – 1 and Midterm, Final**
Lecture 1	Motivation course – Need for bioinformatics in biological sequence analysis	
Lecture 2	The central dogma of biology – DNA	
Lecture 3	The central dogma of biology- RNA	
2	**Molecular genetics tools and analysis**	
Lecture 4	Analyzing and sequencing nucleic acids	
Lecture 5	Structure and hierarchy of proteins	
Lecture 6	Proteomics and genomics in bioinformatics	
3	**Pairwise alignment and dotplots**	
Lecture 7	Biological databases and information retrieval	
Lecture 8	Sequence alignment with dot matrix	
Lecture 9	Alignment visualization with dot matrix tools	
4	**Optimal alignment – dynamic programming**	
Lecture 10	Dot matrix tools – examples and application	
Lecture 11	Optimal alignment using dynamic programming method – nucleic acids	
Lecture 12	Optimal alignment using dynamic programming method – proteins	
5	**Optimal alignment – global and local alignment**	**Midterm, Final**
Lecture 13	Global (Needleman-Wunch) and local (Smith-Waterman) alignment techniques	
Lecture 14	Affine gap penalty models in dynamic programming – use and examples	

Lecture 15	Introduction to statistical significance testing	
6	**Statistical significance of alignment**	
Lecture 16	Statistical significance of global alignment	
Lecture 17	Erdo Renyi theorem	
Lecture 18	Statistical significance of local alignment	
7	**Scoring matrices**	
Lecture 19	Nucleotide identity scoring matrix	
Lecture 20	BLOSUM matrix	
Lecture 21	Construction of BLOSUM matrix from BLOCKS database	
MIDTERM		
8	**Scoring matrices**	**CT – 2, FINAL**
Lecture 22	Accepted point mutation and PAM matrices	
Lecture 23	Constructing PAM matrices	
Lecture 24	Alignment visualization and scoring exercise	
9	**Biological Sequence Retrieval**	
Lecture 25	FASTA and BLAST algorithm	
Lecture 26	Different modes of sequence searches using NCBI-BLAST tool (PSI-BLAST, PHI-BLAST)	
Lecture 27	Sequence retrieval and analysis using BLAST	
10	**Multiple sequence alignment**	
Lecture 28	PSI-BLAST, KlustalW and progressive alignment	
Lecture 29	Multiple sequence alignment with KlustalW	
Lecture 30	Position specific scoring matrices, PROSITE database	
11	**Introduction to phylogenetics**	**CT – 3, FINAL**
Lecture 31	Introduction to phylogenetics	
Lecture 32	Drawing tree diagrams	
Lecture 33	Introduction to tree building methods	
12	**Constructing phylogenetics tree 1**	
Lecture 34	Stepwise clustering 1	
Lecture 35	Stepwise clustering 2	
Lecture 36	Fitch Margoliash method	
13	**Constructing phylogenetics tree 2**	**FINAL**
Lecture 37	Maximum parsimony and maximum likelihood method	
Lecture 38	Ancestral studies using phylogeny	
Lecture 39	Phylogenetic tools and software based exercise	
14	**Gene prediction**	
Lecture 40	Modeling genes	
Lecture 41	Finding protein coding areas of the gene	
Lecture 42	Revision	
FINAL EXAMINATION		
ASSESSMENT STRATEGY		

			CO	Blooms Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C2, C3, C6
	Class Participation/Assignment	5%	CO3	C3
	Midterm	15%	CO1, CO2	C2, C6
Final Exam		60%	CO 1	C2
			CO 2	C6
			CO 3	C3
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

REFERENCE BOOKS

1. Understanding Bioinformatics, Jeremy Baum (2008), Taylor and Francis, NY, USA

2. An Introduction to Bioinformatics Algorithms - by Neil C. Jones, Pavel A. Pevzner

REFERENCE BOOKS

1. Baxevanis, A.D., and Ouellette, B.F.F. (2005) Bioinformatics -A Practical Guide to the Analysis of Genes and Proteins, 3rd ed., John Wiley and Sons, NY
2. Mount, D.W. (2004) Bioinformatics: Sequence and Genome Analysis, 2nd ed., Cold Spring Harbor Lab. Press, N.Y.
3. Online sequence databases and bioinformatic tools

REFERENCE SITE

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6.2.3 Group-III (Imaging)

6.2.3.1 BME 427 Advanced Biomedical Signal Processing

COURSE INFORMATION			
Course Code Course Title	: BME 427 : Advanced Biomedical Signal Processing	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME 305: Biomedical Signal Processing
MATH 231: Complex Variable and Linear Algebra

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course is designed to provide strong foundation of theoretical knowledge in advanced signal processing techniques to implement them in complex biosignal analysis for solving associated real-life problems.

OBJECTIVE

1. To provide the knowledge about the different advanced signal processing techniques for non-stationary signals
2. To prepare the students skilled to reveal the complex meaning of different biosignals and systems.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the steps of different advanced signal processing techniques	C2	1	1	-	1,3	T, F
CO2	Be able to **apply** the advanced signal processing techniques to different biosignals appropriately	C3	1	1,3	-	1,2	MID, F
CO3	Be able to **make decision** about problem based signal processing techniques	C3	1	1	-	1,2	T, F
CO4	Be able to **analyze** different biosignals and systems to reveal the complex meaning of different biosignals and systems	C4	2	1,2	-	1,3	T, F
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Biomedical signal recording system: Review on Biomedical signals and system, spectral characteristics of biomedical signals, bio-sensors and acquisition of biomedical signals, sampling, quantization and encoding, multi-rate data acquisition systems, compressed sensing; time-domain analysis of biomedical signals; **Statistical analysis of biosignals:** Biomedical signals using higher order higher order statistics (HOS), Principal component analysis (PCA), Independent component analysis (ICA), Common spatial pattern (CSP), Singular value decomposition (SVD), Singular spectrum analysis (SSA) etc. Estimation of power spectrum and correlation analysis.
Time-frequency domain analysis of biomedical signals: short-time Fourier transform, wavelet transform, empirical mode decomposition; **Digital filters for processing biomedical signals**: different types of artifacts and noise, filters in time-domain and frequency-domain, time-frequency domain-based filtering; **Event detection and feature extraction**: signal segmentation, envelope extraction, temporal and spectral features, statistical features, pattern classification using neural networks and support vector machine; **Modeling biomedical systems:** autoregressive model, pole-zero and spectral modeling, Linear mixture modelling, applications of biomedical systems.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the steps of different advanced signal processing techniques	2											
CO2	Be able to **apply** the advanced signal processing techniques to different biosignals appropriately	2											
CO3	Be able to **make decision** about problem based signal processing techniques	3											
CO4	Be able to **analyze** different biosignals and systems to reveal the complex meaning of different biosignals and systems	3											
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE		
Week	**Topic**	**Assessment**
1	**Biomedical signal recording system**	**CT – 1, Final**
Lecture 1	Review on Biomedical signals and system	
Lecture 2	Spectral characteristics of biomedical signals	
Lecture 3	Bio-sensors and acquisition of biomedical signals	
2	**Biomedical signal recording system**	
Lecture 4	Sampling, quantization and encoding	
Lecture 5	Multi-rate data acquisition systems, compressed sensing	
Lecture 6	time-domain analysis of biomedical signals	
3	**Statistical analysis of biosignals**	
Lecture 7	Biomedical signals using higher-order statistics (HOS)	
Lecture 8		
Lecture 9		
4	**Linear Transformation**	**Midterm, Final**
Lecture 10	Principal component analysis (PCA)	
Lecture 11	Principal component analysis (PCA)	
Lecture 12	Independent component analysis (ICA)	
5	**Linear Transformation**	
Lecture 13	Independent component analysis (ICA)	
Lecture 14	Common spatial pattern (CSP)	
Lecture 15	Common spatial pattern (CSP)	
6	**Linear Transformation**	
Lecture 16	Singular value decomposition (SVD)	
Lecture 17	Singular value decomposition (SVD)	
Lecture 18	Singular spectrum analysis (SSA)	
7	**Linear Transformation**	
Lecture 19	Singular spectrum analysis (SSA)	
Lecture 20	Estimation of power spectrum and correlation analysis	
Lecture 21	Estimation of power spectrum and correlation analysis	
Midterm Break		
8	**Time-frequency domain analysis of biomedical signals:**	**CT – 2, Final**
Lecture 22	Short-time Fourier transform	
Lecture 23	Short-time Fourier transform	
Lecture 24	Wavelet transform	
9	**Time-frequency domain analysis of biomedical signals**	
Lecture 25	Wavelet transform	
Lecture 26	Empirical mode decomposition	
Lecture 27	Empirical mode decomposition	
10	**Digital filters for processing biomedical signals**	
Lecture 28	Different types of artifacts and noise	
Lecture 29	Filters in time-domain and frequency-domain	
Lecture 30	Time-frequency domain-based filtering	
11	**Event detection and feature extraction**	
Lecture 31	Signal segmentation	
Lecture 32	Envelope extraction	

Lecture 33	Temporal and spectral features	CT – 3, FINAL
12	**Event detection and feature extraction**	
Lecture 34	Statistical features	
Lecture 35	Pattern classification using neural networks	
Lecture 36	Pattern classification using support vector machine	
13	**Modeling biomedical systems**	FINAL
Lecture 37	Autoregressive model	
Lecture 38	Pole-zero and spectral modeling	
Lecture 39	Pole-zero and spectral modeling	
14	**Biomedical Signal Processing**	
Lecture 40	Linear mixture modelling	
Lecture 41	Applications of biomedical systems	
Lecture 42	Applications of biomedical systems	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Emmanuel Ifeachor and Barrie Jervis, "Digital Signal Processing: A Practical Approach," Second Edition, Pearson Publications, 2002.
2. Amine Nait-Ali, "Advanced Biosignal Processing," Springer, 2009.

REFERENCE BOOKS

3. K J Blinowska and J Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB," CRC Press, 2012.
4. S. R. Devasahayam, "Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling," Second Edition, Springer Publication, 2013.

REFERENCE SITE

6.2.3.2 BME 429 Nuclear Medicine

COURSE INFORMATION			
Course Code Course Title	: BME 429 : Nuclear Medicine	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
PRE-REQUISITE			
PHY 125 & 103: Physics I and II BME 307 – Medical Imaging			
CURRICULUM STRUCTURE			
Outcome Based Education (OBE)			
SYNOPSIS/RATIONALE			
The course introduces the students to the physics of radionucleotide and radionucleotide decay, radionucleotide generators and detection. Emphasis is given on medical cyclotrons for producing radioisotopes used in molecular imaging. Radionucleotide detection using Gamma camera and other related method is also covered. Few key nuclear imaging methods, namely, SPECT, SPECT-CT, PET, PET-CT are covered in sufficient details.			
OBJECTIVE			
1. Be able to **understand** the basic concepts of radionucleotide decay and radioactive equilibrium 2. Be able to **describe** the physics and working principles of instruments used in nuclear medicine 3. Be able to **apply** fundamental concepts learnt in the course to address issues in nuclear imaging 4. Be able to **undertake** quality control and testing of instruments used in nuclear medicine			

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **understand** the basic concepts of radionucleotide decay and radioactive equilibrium	C2	1	-	-	1	T, MID
CO2	Be able to **describe** the physics and working principles of instruments used in nuclear medicine	C1, C2	1	1	1	1	T, MID, F
CO3	Be able to **apply** fundamental concepts learnt in the course to address issues in nuclear imaging	C3, C4	2	-	1	2	ASG
CO4	Be able to **undertake** quality control and testing of instruments used in nuclear medicine	C3, C4	2	1	1	2	T,F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 - Create

COURSE CONTENT

Planar Scintigraphy: Introduction of Nuclear medicine: Planar scintigraphy, Radioactivity and radiotracer half-life, Properties of radiotracers for nuclear medicine, The technetium generator, The distribution of technetium-based radiotracers within the body, The gamma camera, Image characteristics, Clinical applications of planar scintigraphy

SPECT and PET/CT: Single photon emission computed tomography (SPECT), Data processing in SPECT, SPECT/CT, Clinical applications of SPECT and SPECT/CT, Positron emission tomography (PET), Radiotracers used for PET/CT, Handling and Operation of PET/CT, Two-dimensional and three-dimensional PET imaging, PET/CT, Data processing in PET/CT, Image characteristics, Time-of flight PET, Clinical applications of PET/CT.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **understand** the basic concepts of radionucleotide decay and radioactive equilibrium	3											
CO2	Be able to **describe** the physics and working principles of instruments used in nuclear medicine	3											
CO3	Be able to **apply** fundamental concepts learnt in the course to address issues in nuclear imaging		3										
CO4	Be able to **undertake** quality control and testing of instruments used in nuclear medicine		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Content	Assessment
1	**Motivation and course introduction**	

Lecture 1	Introduction and Motivation	**CT – 1 and Midterm, Final**
Lecture 2	Overview on Medical Imaging	
Lecture 3	Introduction and history of nuclear medicine	
2	**Nuclear Medicine**	
Lecture 4	Radionucleotide decay and the fundamental decay equation	
Lecture 5	Photon beam attenuation	
Lecture 6	Beams and procedures used in nuclear medicine and radiopharmaceuticals	
3	**Radioactive equilibrium**	
Lecture 7	Radioactive equilibrium – decay and transmutation	
Lecture 8	Activity and half-life of radionucleotides, carrier free specific activity	
Lecture 9	Radioactivity in equilibrium – Bateman equations, secular and transient equilibrium	
4	**Radionucleotide production**	
Lecture 10	Methods for producting radionucleotides	
Lecture 11	Nuclear reactor, nuclear fission, neutron activated produced radionucleotides	
Lecture 12	Accelerator produced radionucleotides, radioisotopes, conventional vs nuclear imaging	
5	**Radionucleotide generators**	**Midterm, Final**
Lecture 13	Ideal nuclear generators and construction of nuclear generators	
Lecture 14	Activity of radionucleotides inside generators	
Lecture 15	Essential steps in accelerator-based radionucleotide production	
6	**Radionucleotide production rates and cyclotron**	
Lecture 16	Production rates and cross-sections	
Lecture 17	Proton generation rate, medical cyclotron	
Lecture 18	Basic working principles and construction method of a simple cyclotron	
7	**Cyclotron - continued**	
Lecture 19	Output energy, heat deposition, stopping power (Bethe Equation)	
Lecture 20	Maintenance of cyclotron	
Lecture 21	Revision	
	MIDTERM	
8		**CT – 2, FINAL**
Lecture 22	**Gamma Camera**	
Lecture 23	Gamma Camera – Introduction and working principles	
Lecture 24	Collimator, collimator efficiency and collimator resolution, collimator sensitivity	
9	Scintillator, pre-amplifier, amplifier	
Lecture 25	**Gamma Camera QC**	
Lecture 26	Photomultiplier tubes and other components of Gamma Camera	
Lecture 27	Energy calculations and Compton Band	
10	Pulse height spectrometry	
Lecture 28	**Gamma Camera QC 2**	

Lecture 29	Image non-uniformity and corrections. Image non-linearity, uniformity profile	
Lecture 30	Gamma Camera tuning, intrinsic uniformity	
11	Design and Performance characteristics of Parallel Hole Collimators, septal thickness	**CT – 3, FINAL**
Lecture 31	**Radiation protection**	
Lecture 32	Types of radiation detectors and comparison with gamma camera	
Lecture 33	Occupational dose limits	
12	**SPECT/SPECT CT imaging**	
Lecture 34	Calculations and examples of dosage and limits	
Lecture 35	Principles and workflow of SPECT imaging	
Lecture 36	Principles and working principles of SPECT-CT imaging	
13	**PET/PET CT imaging**	**FINAL**
Lecture 37	Principles and workflow of PET imaging	
Lecture 38	Principles and workflow of PET-CT imaging	
Lecture 39	Image construction and processing of PET-CT images	
14	**Non imaging devices**	
Lecture 40	Dose calibrators, QC of dose calibrators, thyroid uptake probe	
Lecture 41	Standard uptake value and noise equivalent count rate	
Lecture 42	Revision	
FINAL EXAMINATION		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4	C1, C2, C3, C4
	Class Participation/Assignment	5%	CO1, CO2, CO3, CO4	C1, C2, C3, C4
	Midterm	15%	CO1, CO2	C1, C2
Final Exam		60%	CO 1	C1
			CO 2	C1, C2
			CO 3	C3. C4
			CO 4	C3, C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. The Essential Physics of Medical Imaging by J.T. Bushberg, J.A. Seibert
2. Physics and Radiobiology of Nuclear Medicine by Gopal B. Saha

REFERENCE BOOKS

1. Nuclear Medicine Physics: A Handbook for Teachers and Students, International atomic energy agency Vienna, 2014

REFERENCE SITE

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6.2.3.3 BME 431 Biomedical Data Science

COURSE INFORMATION			
Course Code Course Title	: BME 431 : Biomedical Data Science	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

Course Code: CSE 291
Course Title: Computer Programming
Course Code: CSE 292
Course Title: Computer Programming Lab
Course Code: BME 301
Course Title: Statistics and Numerical Methods for Biomedical Engineers
Course Code: BME 313
Course Title: Biomedical Image Processing
Course Code: BME 314
Course Title: Biomedical Image Processing Sessional

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

The goal of this course is to expose students to the field of data science and computer vision. The course will provide students a solid background of machine learning and deep learning, this will enable students to solve various problems in the domain of medical imaging, bioinformatics, medical device development and biomedical implants using Artificial Intelligence. Student will undergo graded coding assignments, which will enable them to implement different aspects of machine learning and deep learning in solving problems of various domains.

OBJECTIVE

1. To identify and understand fundamentals of artificial intelligence.
2. To apply the fundamental concepts of machine learning and deep learning in the domain of biomedical data science.
3. To analyze the various machine learning algorithms.
4. To evaluate various deep learning architectures.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **identify** and **understand** fundamentals of fundamentals of artificial intelligence	C1, C2	1	1	-	3	T, F
CO2	Be able to **apply** the fundamental concepts of machine learning and deep learning in the domain of biomedical data science.	C3	2	1,3	-	3	T, F
CO3	Be able to **analyze** the various machine learning algorithms.	C4	2	1	-	5	MID, F
CO4	Be able to **evaluate** various deep learning architectures.	C5	3	1,3	-	5	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile,T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Introduction to Python for Data Science: Data Types, Loops, Functions, Reading and Writing Files, Object Oriented programming, Threading, Multiprocess, Libraries: numpy, matplotlib, Pandas, OpenCV, Sklearn, Tensorflow, sea born. Dealing with null values. **Pattern Recognition:** Data clustering, Supervised Learning, Unsupervised Learning, Introduction to Fuzzy logic. **Machine Learning:** Architecture (Feature Extraction, Training, Testing, Validation), Semi Supervised Learning, Linear Regression, Logistic Regression, kNN, Decision Tree, Random Forest, Naïve Bayes Classifier, Support vector machine, ANN, Over Fitting and Regularization. **Deep Learning:** Architecture, Activation Functions, Perceptrons, Multi-Layer Perceptrons, CNN, RNN. LSTM, Data Augmentations, Transfer Learning, Self attention, Encoder-Decoder, Introduction to different pertained network.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **identify** and **understand** fundamentals of fundamentals of artificial intelligence	3											
CO2	Be able to **apply** the fundamental concepts of machine learning and deep learning in the domain of biomedical data science.		3										
CO3	Be able to **analyze** the various machine learning algorithms.		3										
CO4	Be able to **evaluate** various deep learning architectures.			3									

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY
Lecture and discussion, Co-operative and collaborative method, Problem based method
COURSE SCHEDULE

Week	Topic	Assessment
1	**Motivation and course introduction**	**CT – 1, Final**
Lecture 1	Introduction to Artificial Intelligence	
Lecture 2	Artificial Intelligence in Healthcare	
Lecture 3	Artificial Intelligence in Healthcare (continue)	
2	**Basic Python Programming**	
Lecture 4	Data Types, Loops, Functions, Reading and Writing Files	
Lecture 5	Object Oriented programming	
Lecture 6	Threading, Multiprocess, Libraries: numpy, matplotlib	
3	**Python Programming for Data Science And computer Vision**	
Lecture 7	Introduction to Pandas, Introduction to OpenCV	
Lecture 8	Introduction to Sklearn	
Lecture 9	Introduction to Tensorflow	
4	**Basic Data Processing and Data Visualization**	**Midterm, Final**
Lecture 10	Data Preprocessing: Dealing with null values, Image resizing, introduction to dimensionality reduction	
Lecture 11	Introduction to sea born: Heat Map, Box Plotm Scatter Plot, 3D plot, Linear Plot, Line Plot	
Lecture 12	Introduction to sea born: Swarmplot, barplot, Distribution Plot, Regression Plot	
5	**Introduction to Pattern Recognition**	
Lecture 13	Supervised Learning, Unsupervised Learning, Semi Supervised Learning	
Lecture 14	Data Clustering	
Lecture 15	Fundamental Concepts of Fuzzy Systems	
6	**Machine Learning Algorithms 1**	
Lecture 16	Linear Regression	
Lecture 17	Logistic Regression	
Lecture 18	Logistic Regression (Continue)	
7	**Machine Learning Algorithms 2**	
Lecture 19	KNN	
Lecture 20	Decision Tree, Random Forest, Naïve Bayes Classifier	
Lecture 21	Support Vector Machine	
	Midterm Break	
8	**Machine Learning Advanced Concepts**	**CT – 2, Final**
Lecture 22	Machine Learning Architecture (Training, Testing and Validation)	
Lecture 23	Over Fitting and Regularization	
Lecture 24	Artificial Neural Networks	
9	**Introduction to Neural Networks**	
Lecture 25	Perceptron, Introduction to Activation Functions, Different Activation Functions	

Lecture 26	Multilayer Perceptron	
Lecture 27	Multilayer Perceptron (Continue)	
10	**Different Neural Network Architectures and Sequential Models 1**	
Lecture 28	Introduction to Convolution Neural Networks, Basic Concepts of CNN: Edge Detection, Padding, CNN Layers, Pooling Layer	
Lecture 29	Different Types of CNN: Resnet	
Lecture 30	Different Types of CNN: Inception	
11	**Different Neural Network Architectures and Sequential Models 2**	**CT – 3, FINAL**
Lecture 31	Different Types of CNN: ImageNet	
Lecture 32	Different Types of CNN: Yolo	
Lecture 33	Data Augmentation	
12	**Different Neural Network Architectures and Sequential Models 3**	
Lecture 34	Introduction to Recurrent Neural Networks and basic principles, Sequential processing with RNN, Bi Directional RNN	
Lecture 35	Introduction to LSTM and basic principles,	
Lecture 36	Sequential Processing with LSTM, Existing LSTM libraries	
13	**Advance Architectures in Neural Network**	**FINAL**
Lecture 37	Transfer Learning	
Lecture 38	Self Attention , Encoder-Decoder Architecture	
Lecture 39	Transformer Model	
14	**Computer Vision in Healthcare**	
Lecture 40	Radiology Diagnostic Scans and Nuclear Medicine Diagnostic Scan	
Lecture 41	Virtual Reality in Healthcare	
Lecture 42	Recent works in Biomedical DataScience	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO3, CO4	C1,C2,C3, C4, C5
	Class Participation	5%	CO1	C1,C2
	Midterm	15%	CO1,CO2, CO3	C1,C2,C3, C4
Final Exam		60%	CO 1	C1, C2
			CO 2	C3
			CO 3	C4
			CO 4	C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1.Pattern Recognition and Machine Learning, bishop, C. (2006), Berlin: Springer-Verlag

2. Deep Learning with Python, Francois Chollet, 2017, Manning Publication

REFERENCE BOOKS

1. Speech and Language Processing, Dan Jurafsky and James H. Martin, 2019, Pearson 2. Head First Python, Paul Barry, 2010, O'Reilly
REFERENCE SITE
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6.2.4 Group-IV (Biomechanics and Rehabilitation Engineering)

6.2.4.1 BME 433 Applied Biofluid Mechanics

COURSE INFORMATION			
Course Code Course Title	: BME 433 :Applied Biofluid Mechanics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE
Course Code: BME 203 Course Title: Biofluid Mechanics and Heat Transfer
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course will provide a discussion of the fluid mechanical principles underlying the operation of physiologic systems, including the heart and circulatory system and the lungs and pulmonary system. Topics to be covered will include blood rheology, mechanics of circulation, arterial wave propagation, oscillatory air and liquid flows and transport of dissolved or suspended solutes. Emphasis will be placed on developing quantitative understanding of blood flow through the arterial system and air flow through the pulmonary system, both in health and in disease.
OBJECTIVE
This course aims to develop student's basic knowledge of fluid mechanics and biofluids to an advance level. The student will gain the understanding of the underlying assumptions and models that are applied when solving fluid mechanics problems. Based on the assumptions made, the student will learn to differentiate between the various approaches and solutions applied to a wide variety of fluid mechanics problems related to physiological processes, medical devices, and laboratory setups as used for testing and measuring. A significant objective is to reinforce the student's prior knowledge in calculus, differential equations, and engineering as it applies to fluid mechanics. Computational Fluid Dynamics (CFD) and MATLAB will be introduced to emphasize Computer Aided Engineering (CAE).
COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to gain fundamental **understanding** of the governing physics behind the pulsatile flow and cardiovascular system.	C2	1	1	-	1	T, F
CO2	Be able to **formulate** the solution related to fluid mechanics problems in human body system and solve by engineering concepts.	C6	3	1,3	-	1,3	T, F
CO3	Be able to **evaluate** artificial organs and devices that are exposed, or work based the flow inside human body.	C5	4	1	-	1	MID, F
CO4	Be able to **analyze** biofluid mechanics problems in human body to improve healthcare.	C4	2	1	-	1,3	T, F
CO5	Be able to **critically** review recent articles from the scientific literature and identify	C6	3,9,12	5	5	5	PR, Pr, R

	relevant areas of research opportunities.						

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Review of basic fluid mechanics, Biorheology: Constitutive equations, Non-Newtonian fluid models; Circulatory biofluid mechanics: Circulatory system physiology, Function of circulatory system, circulation in heart, blood and lymphatic vessels, Blood properties, Hemorheology; Models for blood flow: Steady flow in tubes, Pulsatile flow in a rigid tube, Pulsatile flow in an elastic tube, Wave propagation in elastic tubes; Applications in circulatory system: Blood flow dynamics in arteries and veins, Flow in specific vessels and arteries, Heart-valve hemodynamic, Diseases related to obstruction of blood flow: Stroke, Heart injury; Synovial fluid in joints: Synovial joints physiology, Function of synovial fluid, Diseases, Synovial fluid properties and rheology, Lubrication theory, Application for synovial fluid flow (Arthritis), Knee and Hip injury; Biofluid dynamics of the human brain: Cerebrospinal fluid, Cerebral blood flow, Blood brain barrier, Brain diseases; Respiratory biofluid mechanics: Respiratory system physiology Alveolar ventilation, Air flow in the lungs, Mechanics of breathing, Gas exchange and transport; Flow and pressure measurement techniques in human body.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to gain fundamental **understanding** of the governing physics behind the pulsatile flow and cardiovascular system.	3											
CO2	Be able to **formulate** the solution related to fluid mechanics problems in human body system and solve by engineering concepts.			2									
CO3	Be able to **evaluate** artificial organs and devices that are exposed, or work based the flow inside human body.				2								
CO4	Be able to **analyze** biofluid mechanics problems in human body to improve healthcare.		3										
CO5	Be able to **critically** review recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			2

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21

Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Overview of Fluid mechanics**	**CT – 1, Final**
Lecture 1	Review of basic fluid mechanics	
Lecture 2	Biorheology	
Lecture 3	Constitutive equations	
2	**Biofluid Properties and Circulatory System**	
Lecture 4	Non-Newtonian fluid models	
Lecture 5	Circulatory system physiology	
Lecture 6	Function of circulatory system	
3	**Circulation and it's Function**	
Lecture 7	Function of circulatory system	
Lecture 8	circulation in heart, blood and lymphatic vessels	
Lecture 9	Blood properties	
4	**Hemorheology and Pulsatile Flow**	**Midterm, Final**
Lecture 10	Hemorheology	
Lecture 11	Models for blood flow: Steady and pulsatile flow in rigid tube	
Lecture 12	Pulsatile flow in an elastic tube	
5	**Wave Propagation and Circulatory System Applications**	
Lecture 13	Wave propagation in rigid body	
Lecture 14	Wave propagation in elastic body	
Lecture 15	Application of wave propagation in circulatory system	
6	**Blood Flow Dynamics and Heart Valve**	
Lecture 16	Blood flow dynamics in arteries and veins	
Lecture 17	Flow in specific vessels and arteries (Coronary artery disease)	
Lecture 18	Flow in specific vessels and arteries (Carotid artery disease)	
7	**Blood Flow Dynamics and Heart Valve**	
Lecture 19	Overview of heart valves and their functions	
Lecture 20	Heart-valve hemodynamic	
Lecture 21	Heart valve disease and flow analysis for analyzing heart valve	
Midterm Break		
8	**Disease Related to Blood Flow**	**CT – 2, Final**
Lecture 22	Overview of diseases related to blood flow obstruction	
Lecture 23	Obstructive coronary artery diseases (Stenosis)	
Lecture 24	Tortuosity and Eccentricity in coronary artery disease progression	
9	**Disease Related to Blood Flow**	
Lecture 25	Overview and causes of stroke	

Lecture 26	Obstructive blood flow related to stroke (Carotid artery stenosis)	
Lecture 27	Obstructive blood flow related to stroke (Carotid artery aneurysm)	
10	**Synovial Fluid in Joints**	
Lecture 28	Synovial joints physiology	
Lecture 29	Function and importance of fluid flow in synovial fluid	
Lecture 30	Disease related synovial fluid	
11	**Synovial Fluid in Joints**	
Lecture 31	Synovial fluid properties and rheology	
Lecture 32	Lubrication theory, Application for synovial fluid flow	
Lecture 33	Arthritis, Knee and Hip Injury	
12	**Brain Fluid Dynamics**	
Lecture 34	Cerebrospinal fluid and cerebral blood flow dynamics	
Lecture 35	Blood brain barrier	
Lecture 36	Biofluid mechanics involved in brain disease	**CT – 3, FINAL**
13	**Respiratory System Fluid Dynamics**	
Lecture 37	Alveolar ventilation and air flow in lungs	
Lecture 38	Mechanics of breathings	
Lecture 39	Gas exchange and transport principles	
14	**Flow Measurement Techniques**	**FINAL**
Lecture 40	Overview of different flow measurement techniques in human body	
Lecture 41	Ultrasonic and Electromagnetic flow measurement techniques	
Lecture 42	Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2, CO4	C2, C6, C4
	Class Participation	5%	CO3	C5
	Midterm	15%	CO3	C5
Final Exam		60%	CO 1	C2
			CO 2	C6
			CO 3	C5
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Applied Biofluid Mechanics, Lee Waite and Jerry Fine. ISBN -10: 0-07-147217-7

REFERENCE BOOKS

1. A Brief Introduction to Fluid Mechanics, Young, Munson, and Okiishi; Fifth Edition

REFERENCE SITE

6.2.4.2 BME 435 Biomedical Implants and Braces

COURSE INFORMATION			
Course Code Course Title	: BME 435 : Biomedical Implants	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course targets the solution of clinical problems by use of implants and other medical devices. Topics include the systematic use of cell-matrix control volumes; the role of stress analysis in the design process; anatomic fit, shape and size of implants; selection of biomaterials; instrumentation for surgical implantation procedures; preclinical testing for safety and efficacy, including risk/benefit ratio assessment evaluation of clinical performance and design of clinical trials, surface modification, corrosion and tribocorrosion aspects of implants and clinical concern etc.

OBJECTIVE

1. To familiarize students with various types of implants and their properties.
2. To introduce with different biomaterials involved in implant design.
3. To analyze different design consideration and standard required for implant designing and fabrication.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **explain** principles of implant modelling	C2	1	1	-	1	T, F
CO2	Be able to **apply** the knowledge of biomaterial selection and design consideration for implant designing	C3	1,3	1	-	1	T, F
CO3	Be able to **analyze** possible failure mechanism that can affect the performance and longevity of the implant	C4	2,8	1	-	1,3	MID, F
CO4	Be able to **evaluate** implant monitoring and different diagnostic techniques involved in implant monitoring	C5	2	1	-	1,3	T, F
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Clinical Problems Requiring Implants for Solution: introduction to irreversibility of injury, overview of regeneration, problems and recommended implants for solution. Principles of Implant design; Missing Organ and Its Replacement: transplantation, autografting, permanent prosthesis, stem cells, in vitro synthesis, induced organ regeneration. Biomaterial for Implants: types and requirements for ideal implant materials, functional properties, surface characterization and preparation, sterilization. Instruments for Surgical Implantation Procedures; Implants for Bone: clinical problem, materials for bone implants, application and procedure involved in bone implantation. Spinal Implants; Dental and Otologic Implant; Implants for Plastic Surgery: materials and their properties, chin implants, jaw implants and chick implants. Implants for Cardiovascular System: cardiac resynchronization therapy and cardiac assisted devices, pacemaker and implantable cardiac defibrillator. Biocompatibility: Local and Systemic Effects; Degradation of Device: corrosion of Metals, degradation of nonabsorbable and absorbable polymers. Nerve Regeneration: synthesis of nerve fibers, device for nerve stimulation (TENS and EMS). Diagnostic Techniques Available for Implant Monitoring.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **explain** principles of implant modelling	3											
CO2	Be able to **apply** the knowledge of biomaterial selection and design consideration for implant designing	3		2									
CO3	Be able to **analyze** possible failure mechanism that can affect the performance and longevity of the implant		3						1				
CO4	Be able to **evaluate** implant monitoring and different diagnostic techniques involved in implant monitoring		3										
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						3			3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY
Lecture and discussion, Co-operative and collaborative method, Problem based method
COURSE SCHEDULE

Week	Topic	Assessment
1	**Clinical Problems Requiring Implants for Solution**	CT – 1, Final
Lecture 1	Introduction to irreversibility of injury	
Lecture 2	Overview of regeneration: spontaneous and induced	
Lecture 3	Problems and recommended implants for solution	
2	**Principles of Implant design**	
Lecture 4	Functional performance of the device (mechanical, chemical and attachment vehicle)	
Lecture 5	Effects of the implant on the body	
Lecture 6	Effects of the body on the implant	
3	**Missing Organ and Its Replacement**	
Lecture 7	Overview of the methods to use for organ replacement	
Lecture 8	Transplantation, Autografting, Permanent prosthesis	
Lecture 9	Stem cells, In vitro synthesis, Induced organ regeneration	
4	**Biomaterial for Implants**	Midterm, Final
Lecture 10	Types and requirements for ideal implant materials	
Lecture 11	Functional properties of the biomaterials (Bulk properties, Surface properties and Chemical Properties)	
Lecture 12	Surface characterization and preparation, Sterilization	
5	**Instruments for Surgical Implantation Procedures**	
Lecture 13	Classes of instruments by function for surgical implantation procedures	
Lecture 14	Functions of the instruments	
Lecture 15	Characteristics and uses of the instruments	
6	**Implants for Bone**	
Lecture 16	Clinical problems that required bone implant	
Lecture 17	Biomaterial used for bone implants (functional, chemical and mechanical properties)	
Lecture 18	Application and procedure involved in bone implantation	
7	**Spinal Implants**	
Lecture 19	Types of spinal implants (cages, hooks, plates, pedicle screws, rods, spinal cord stimulator)	
Lecture 20	Material used and their characteristics	
Lecture 21	Usage and benefits of spinal implants	
	Midterm Break	
8	**Dental Implant**	
Lecture 22	Types of dental implants and their usage	
Lecture 23	Characteristics and functions of dental implants	
Lecture 24	Implantation procedure involved in dental surgery	
9	**Implants for Plastic Surgery**	

Lecture 25	Overview if implants used for plastic surgery	**CT – 2, Final**
Lecture 26	Materials used in plastic surgery and their properties	
Lecture 27	Chin implants, jaw implants and chick implants	
10	**Implants for Cardiovascular System**	
Lecture 28	Introduction to implantable cardiac devices	
Lecture 29	Overview of pacemaker and implantable cardiac defibrillator, stent (material and functions), Heart Valves	
Lecture 30	Overview cardiac resynchronization therapy and cardiac assisted devices	
11	**Biocompatibility: Local and Systemic Effects**	**CT – 3, FINAL**
Lecture 31	Overview of biocompatibility	
Lecture 32	Chemical effect related to biocompatibility	
Lecture 33	Mechanical effect: alteration on strains in surrounding tissue, Electrical and Thermal effects	
12	**Degradation of Device**	
Lecture 34	Corrosion of Metals	
Lecture 35	Degradation of nonabsorbable polymers	
Lecture 36	Degradation of absorbable polymers	
13	**Nerve Regeneration**	**FINAL**
Lecture 37	Parameters for study of nerve regeneration	
Lecture 38	Synthesis of nerve fibers	
Lecture 39	Device for nerve stimulation (TENS and EMS)	
14	**Diagnostic Techniques Available for Implant Monitoring**	
Lecture 40	Overview of diagnostic techniques for implant monitoring	
Lecture 41	Evaluation of bone implant interface and Radiographic Evaluation	
Lecture 42	Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO2, CO3	C2, C3, C5
	Class Participation	5%	-	-
	Midterm	15%	CO3	C4
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C4
			CO 4	C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. LIMSwiki, Introduction to Implants: Devices, Procedures, and Conditions Requiring Them (Volume 1)

REFERENCE BOOKS
1. Yannas, I. V. Tissue and Organ Regeneration in Adults. New York, NY: Springer, 2001. ISBN: 9780387952147.
REFERENCE SITE
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6.2.4.3 BME 437 Neuroscience and Neural Engineering

COURSE INFORMATION			
Course Code Course Title	: BME 437 : Neuroscience and Neural Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

BME- 105: Human Anatomy
BME- 201: Human Physiology

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course aims to provide fundamental knowledge about neuroscience and the basic mechanism of neural engineering and associated devices.

OBJECTIVE

1. To provide knowledge about the fundamental knowledge about the neuroscience
2. To equip students to learn about the basic mechanism of neural engineering and associated devices.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **remember** the functional connectivity of brain with other organs	C1	1	1	-	1,2	T, MID, F
CO2	Be able to **understand** the mechanism of neuroscience, neural engineering, and associated devices	C2	1	1,2	-	1,2	T, F
CO3	Be able to **categorize** appropriate neurorehabilitation for various neural disorders.	C4	1	1	-	1	T, F
CO4	Be able to **apply** neurostimulation techniques to restore nerve activity.	C3	6	1	-	1	T, F
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.	C6	3,9,12	5	5	5	PR, Pr, R

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create

COURSE CONTENT

Brain Anatomy: Biology of brain, Structural anatomy of Brain, Functional Neuroanatomy; **Neuroscience Fundamentals:** Molecular Neuroscience, Neural circuits and systems, Cognitive and Behavioral neuroscience, Neuromuscular junction and motor actions, Sensory neuroscience, Neural information processing and learning; Translational neuroscience and medicine, Clinical neuroscience. **Neural Disorders:** Mechanisms underlying neurological disorders of stroke, Parkinson's disease, Alzheimer's disease or epilepsy, Dementia, Autism;

Nueroplasticity and neurorehabilitation. **Functional Neuroimaging:** Functional neuroimaging basis and applications of EEG, EMG, fMRI, DTI, fNIRS, etc.

Motor System: Pattern of neuro-signal, neurosignal processing, Brain-computer interfaces, Firing rate estimation, Population vectors; **Visual System:** visual evoked potential (VEP), VEP Stimuli, VEP Electrode Placement, VEP Waves and Types, Retinal Implants; **Auditory System:** Auditory evoked potentials, Brainstem auditory evoked potentials, Cochlear Implants; **Neurostimulations:** Introduction to Functional Electrical Stimulation (FES), Muscular FES, Peripheral FES, Electrocortical Stimulation, transcranial magnetic stimulation, deep brain stimulation; **Neuromodulation and Applications:** Noninvasive Neuromodulation Methods and Functional Applications (TMS, rTMS, TDC), Recent Trends of Neural Engineering.

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **remember** the functional connectivity of brain with other organs	3											
CO2	Be able to **understand** the mechanism of neuroscience, neural engineering, and associated devices	2											
CO3	Be able to **categorize** appropriate neurorehabilitation for various neural disorders.	2											
CO4	Be able to **apply** neurostimulation techniques to restore nerve activity.						3		1				
CO5	Be able to critically **review** recent articles from the scientific literature and identify relevant areas of research opportunities.			3						9			3

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week	Topic	Assessment
1	**Brain Anatomy**	**CT – 1, Final**
Lecture 1	Biology of brain, Structural anatomy of Brain	
Lecture 2	Functional Neuroanatomy	
Lecture 3	Functional Neuroanatomy	
2	**Neuroscience Fundamentals**	
Lecture 4	Molecular Neuroscience	
Lecture 5	Neuromuscular junction and motor actions	
Lecture 6	Neuromuscular junction and motor actions	
3	**Neuroscience Fundamentals**	
Lecture 7	Cognitive and Behavioral neuroscience	
Lecture 8	Neural circuits and systems	
Lecture 9	Neural circuits and systems	
4	**Neuroscience Fundamentals**	**Midterm, Final**
Lecture 10	Sensory neuroscience	
Lecture 11	Neural information processing and learning	
Lecture 12	Translational neuroscience and medicine, Clinical neuroscience	
5	**Neural Disorders**	
Lecture 13	Mechanisms underlying neurological disorders of stroke, , ,	
Lecture 14	Parkinson's disease	
Lecture 15	Alzheimer's disease or epilepsy	
6	**Neural Disorders**	
Lecture 16	Dementia	
Lecture 17	Autism	
Lecture 18	Nueroplasticity and neurorehabilitation	
7	**Functional Neuroimaging**	
Lecture 19	Functional neuroimaging basis and applications of EEG, EMG, fMRI, DTI, fNIRS, etc	
Lecture 20		
Lecture 21		
Midterm Break		
8	**Motor System**	**CT – 2, Final**
Lecture 22	Pattern of neuro-signal,	
Lecture 23	Neurosignal processing, Brain-computer interfaces,	
Lecture 24	Firing rate estimation, Population vectors	
9	**Visual System**	
Lecture 25	Visual evoked potential (VEP), VEP Stimuli,	
Lecture 26	VEP Electrode Placement, VEP Waves and Types	
Lecture 27	Retinal Implants	
10	**Auditory System**	
Lecture 28	Auditory evoked potentials	
Lecture 29	Brainstem auditory evoked potentials	
Lecture 30	Cochlear Implants	
11	**Neurostimulations**	
Lecture 31	Introduction to Functional Electrical Stimulation (FES)	
Lecture 32	Muscular FES	

Lecture 33	Peripheral FES	CT – 3, FINAL
12	**Neurostimulation**	
Lecture 34	Electrocortical Stimulation	
Lecture 35	Transcranial magnetic stimulation	
Lecture 36	Deep brain stimulation	
13	**Neuromodulation and Applications**	FINAL
Lecture 37	Noninvasive Neuromodulation	
Lecture 38	Methods and Functional Applications (TMS, rTMS, TDC),	
Lecture 39		
14	**Neuromodulation and Applications**	
Lecture 40	Recent Trends in Neural Engineering	
Lecture 41	Case study on Recent Applications	
Lecture 42		

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)

TEXT BOOKS

1. Dale Purves, George J. Augustine, and et.al, "Neuroscience" Third Edition, Sinauer Associates, 2004.
2. Charles Watson, Matthew Kirkcaldie, and George Paxinos, "The Brain: An Introduction to Functional Neuroanatomy," Academic Press, 2010..

REFERENCE BOOKS

1. Metin Akay (Edited), "Handbook of Neural Engineering," IEEE Press, 2007.

REFERENCE SITE

6.2.4.4 BME 439 Biofabrication

COURSE INFORMATION

Course Code	: BME 439	Lecture Contact Hours	: 3.00
Course Title	: Biofabrication	Credit Hours	: 3.00

PRE-REQUISITE

Course Code: BME 303
Course Title: Biomaterials
Course Code: ME 291
Course Title: Principles of Mechanical Engineering

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

This course covers the module that include fabrication technology, protype fundamentals, CNC and CAM manufacturing, liquid, solid and powder based prototyping, biosensor fabrication, tissue regeneration, 3d organ printing and rapid prototyping for bone and prosthetics.

OBJECTIVE

1. To develop knowledge and understanding of the commercial use of additive manufacture and 3D printing for biomedical applications.
2. To learn how to use biomedical CAD/CAM software to design person specific medicaldevices.
3. To develop knowledge and understanding of biomaterials, and specifically how to select and evaluate biomaterials for a specific application.
4. To develop knowledge and understanding of bioprinting and biofabrication, and specifically the techniques by which cells and other biological materials may be processed.
5. To develop knowledge and understanding of the additive manufacture processes and process chains which can be used in biomedical applications, including those for biofabrication.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Outcome	Bloom's Taxonomy	PO	CP	CA	KP	Assessment Methods
CO1	Be able to **explain** different additive manufacturing technologies available in the context of biofabrication.	C2	1	1	-	1,3	T, F
CO2	Be able to **understand** the benefits of additive manufacture in biomedical applications, bioprinting and biofabrication.	C2	1	1,3	-	1,3	T, F
CO3	Be able to work from a defined need to **develop** a product based on biomedical additive manufacture, including definition of the product workflow, the manufacturing process chain, and the route to market.	C6	3,4	1	-	1	MID, F
CO4	Be able to **evaluate** and **develop** opinions on the 3D printing industry and the resulting biomedical applications.	C5 & C6	2	1	-	1	T, F

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam)

C1 - Remember	C2 - Understand	C3 - Apply	C4 - Analyze	C5 - Evaluate	C6 - Create
COURSE CONTENT					

Introduction to Fabrication Technology, Overview of fabrication technique, Traditional vs Nontraditional machining, Traditional machining: Turning, Milling, Drilling, Boring, Reaming, Nontraditional Machining, Joining technology and Molding, Introduction to various non-traditional machining (Mechanical, Electrical, Electro-thermal and Chemical) process, Introduction to welding (Laser welding, electron beam welding) and soldering, Overview of molding processes (casting, compression molding, injection molding, extrusion molding), Introduction to Rapid Prototyping (RP), Fabrication Technologies, Prototype fundamental, Primary consideration and advantages of rapid prototyping, Classification and functions of different rapid prototyping techniques, Overview of CNC and CAM (Manufacturing), Introduction to computer numerical control (CNC) and computer assisted manufacturing (CAM) techniques, Manual and CAM control of CNC machine (Purpose of G-code, M-code and alphabetical command), Different types of tooling required for CNC mills, lathes and machine centers, Rapid Prototyping Process, Automated process, process chain, Overview of 3D modeling, data conversion and transmission, Preparation of model, building and postprocessing, Liquid-Based Rapid Prototyping Systems, Overview of few techniques involved liquid-based RP system (stereolithography apparatus (SLA), cubital's solid ground curing (SGC)), Overview of solid creation system (SCS) and solid object ultraviolet-laser printer (SOUP), Other liquid-based RP systems and microfabrication, Solid-Based RP systems

Introduction to laminated object manufacturing (LOM), fused deposition modeling (FDM), Techniques of paper lamination technology (PLT), Mult-jet modeling system (MJM), Few more solid-based RP techniques (SSM, MEM, M-RPM etc.), Powder-Based Rapid Prototyping Systems, 3D Systems' Selective Laser Sintering (SLS), Z Corporation's Three-Dimensional Printing (3DP), Optomec's Laser Engineered Net Shaping (LENS),, Fraunhofer's Multiphase Jet Solidification (MJS), RP Data Formation, STL file format and problems regarding, STL file formats, Consequences of building a valid and invalid tessellated model, STL file repair, newly proposed formats and standards for representing layered manufacturing, Process Parameters and General Engineering Applications, Application-Material Relationship, Finishing Processes, Applications in Design, Analysis and Planning, Applications in Manufacturing and Tooling; Aerospace Industry; Automotive Industry; Jewelry Industry, RP techniques for biosensor fabrication, Introduction to uses of RP in biosensor fabrication, RP of microfluidic system, Functionalization of biosensor and biomaterials compatibility, RP for Tissue Regeneration, RP technologies in tissue regeneration, Rationale for using laser assisted bioprinting (LAB), LAB parameters for cell printing, RP for Scaffold Fabrication, 3D Organ Printing – Microvascular, Biomimetic model for microvasculature printing, , Microvasculature printing strategies, Microvasculature post-printing stage, RP for bone and prosthetic limb, Bone: properties, structure, and modelling, The aim in designing a prosthetic limb, A biomimetic approach to design and fabricate Limb

SKILL MAPPING

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **explain** different additive manufacturing technologies available in the context of biofabrication.	3											
CO2	Be able to **understand** the benefits of additive manufacture in biomedical applications, bioprinting and biofabrication.	3											
CO3	Be able to work from a defined need to **develop** a product based on biomedical additive manufacture, including definition of the product workflow, the manufacturing process chain, and the route to market.			3	3								
CO4	Be able to **evaluate** and **develop** opinions on the 3D printing industry and the resulting biomedical applications.		3										

(Numerical method used for mapping which indicates 3 as high, 2 as medium, and 1 as low level of matching)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous and (or) subsequent lecture at home	21
Preparation for final examination	21
Formal Assessment	
Continuous Assessment	2
Final Examination	3
Total	131

TEACHING METHODOLOGY

Lecture and discussion, Co-operative and collaborative method, Problem based method

COURSE SCHEDULE

Week		Assessment
1	**Introduction to Fabrication Technology**	
Lecture 1	Overview of fabrication techniques	
Lecture 2	Traditional vs Nontraditional machining	

Lecture 3	Traditional machining: Turning, Milling, Drilling, Boring, Reaming	
2	**Nontraditional Machining, Joining technology and Molding**	**CT – 1 and Midterm, Final**
Lecture 4	Introduction to various non-traditional machining (Mechanical, Electrical, Electro-thermal and Chemical) process	
Lecture 5	Introduction to welding (Laser welding, electron beam welding) and soldering	
Lecture 6	Overview of molding processes (casting, compression molding, injection molding, extrusion molding)	
3	**Introduction to Rapid Prototyping (RP)**	
Lecture 7	Fabrication Technologies, Prototype fundamental	
Lecture 8	Primary consideration and advantages of rapid prototyping	
Lecture 9	Classification and functions of different rapid prototyping techniques	
4	**Overview of CNC and CAM (Manufacturing)**	**Midterm, Final**
Lecture 10	Introduction to computer numerical control (CNC) and computer assisted manufacturing (CAM) techniques	
Lecture 11	Manual and CAM control of CNC machine (Purpose of G-code, M-code and alphabetical command)	
Lecture 12	Different types of tooling required for CNC mills, lathes and machine centers	
5	**Rapid Prototyping Process**	
Lecture 13	Automated process, process chain	
Lecture 14	Overview of 3D modeling, data conversion and transmission	
Lecture 15	Preparation of model, building and postprocessing	
6	**Liquid-Based Rapid Prototyping Systems**	
Lecture 16	Overview of few techniques involved liquid-based RP system (stereolithography apparatus (SLA), cubital's solid ground curing (SGC))	
Lecture 17	Overview of solid creation system (SCS) and solid object ultraviolet-laser printer (SOUP)	
Lecture 18	Other liquid-based RP systems and microfabrication	
7	**Solid-Based RP systems**	
Lecture 19	Introduction to laminated object manufacturing (LOM), fused deposition modeling (FDM)	
Lecture 20	Techniques of paper lamination technology (PLT), Mult-jet modeling system (MJM)	
Lecture 21	Few more solid-based RP techniques (SSM, MEM, M-RPM etc.)	
	MID TERM	
8	**Powder-Based Rapid Prototyping Systems**	
Lecture 22	3D Systems' Selective Laser Sintering (SLS)	
Lecture 23	Z Corporation's Three-Dimensional Printing (3DP)	
Lecture 24	Optomec's Laser Engineered Net Shaping (LENS), Fraunhofer's Multiphase Jet Solidification (MJS)	

9	**RP Data Formation**	
Lecture 25	STL file format and problems regarding STL file formats	
Lecture 26	Consequences of building a valid and invalid tessellated model	
Lecture 27	STL file repair, newly proposed formats and standards for representing layered manufacturing	
10	**Process Parameters and General Engineering Applications**	
Lecture 28	Application-Material Relationship, Finishing Processes	
Lecture 29	Applications in Design, Analysis and Planning	**CT – 2, FINAL**
Lecture 30	Applications in Manufacturing and Tooling; Aerospace Industry; Automotive Industry; Jewelry Industry	
11	**RP techniques for biosensor fabrication**	
Lecture 31	Introduction to uses of RP in biosensor fabrication	
Lecture 32	RP of microfluidic system	
Lecture 33	Functionalization of biosensor and biomaterials compatibility	
12	**RP for Tissue Regeneration**	
Lecture 34	RP technologies in tissue regeneration	
Lecture 35	Rationale for using laser assisted bioprinting (LAB), LAB parameters for cell printing	
Lecture 36	RP for Scaffold Fabrication	
13	**3D Organ Printing Microvascular**	
Lecture 37	Biomimetic model for microvasculature printing,	**CT – 3, FINAL**
Lecture 38	Microvasculature printing strategies	
Lecture 39	Microvasculature post-printing stage	
14	**RP for Bone and Prosthetic Limb**	
Lecture 40	Bone: properties, structure, and modeling	
Lecture 41	The aim in designing a prosthetic limb	
Lecture 42	A biomimetic approach to design and fabricate Limb	
FINAL EXAMINATION		
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO3, CO4	C2, C4
	Class Participation	5%	CO3	C2
	Midterm	15%	CO2	C3
Final Exam		60%	CO 1	C2
			CO 2	C3
			CO 3	C2
			CO 4	C4
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain)
TEXT BOOKS
1.Rapid prototyping: principles and applications, 2nd edition, Chua C. K., Leong K. F., Lim C. S., World Scientific
REFERENCE BOOKS
1.Rapid prototyping of biomaterials: principles and applications, Woodhead Publishing
REFERENCE SITE
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CHAPTER 7
ANNEX-A

7.1 Program Outcomes

PO-1	**Engineering knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.
PO-2	**Problem analysis:** Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4)
PO-3	**Design/development of solutions:** Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5)
PO-4	**Investigation:** Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO-5	**Modern tool usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6)
PO-6	**The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)
PO-7	**Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)
PO-9	Individual work and teamwork: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11	**Project management and finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

7.2 Knowledge Profile

Attributes	
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

7.3 Range of Complex Engineering Problem Solving

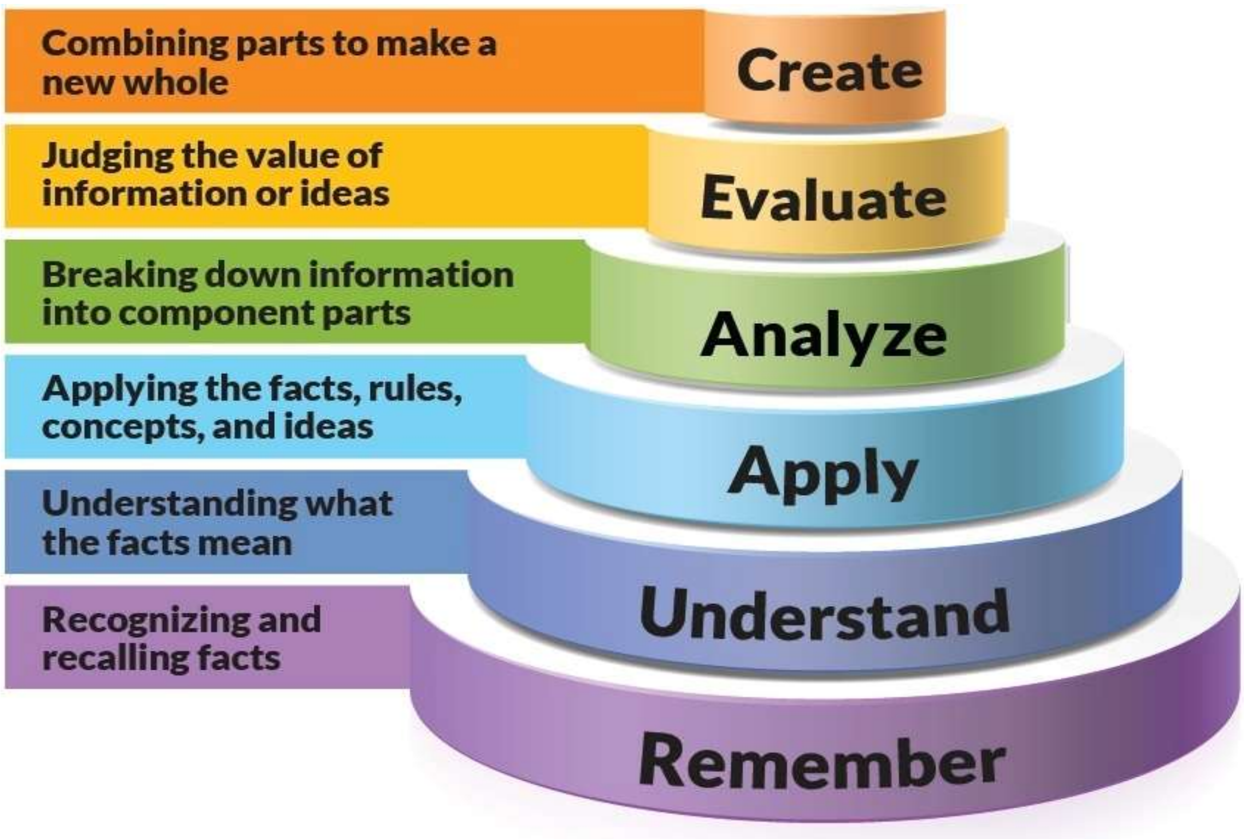
Attributes	**Complex Engineering Problems**
Depth of knowledge required	**P1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	**P2:** Involve wide-ranging or conflicting technical, engineering and other issues

Depth of analysis required	**P3:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	**P4:** Involve infrequently encountered issues
Extent of applicable codes	**P5:** Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	**P6:** Involve diverse groups of stakeholders with widely varying needs
Interdependence	**P7:** Are high level problems including many component parts or sub-problems

7.4 Range of Complex Engineering Activities

Attributes	Complex activities
Range of resources	**A1**: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	**A2**: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	**A3**: Involve creative use of engineering principles and research-based knowledge in novel ways
Consequences for society and the environment	**A4**: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	**A5**: Can extend beyond previous experiences by applying principles-based approaches

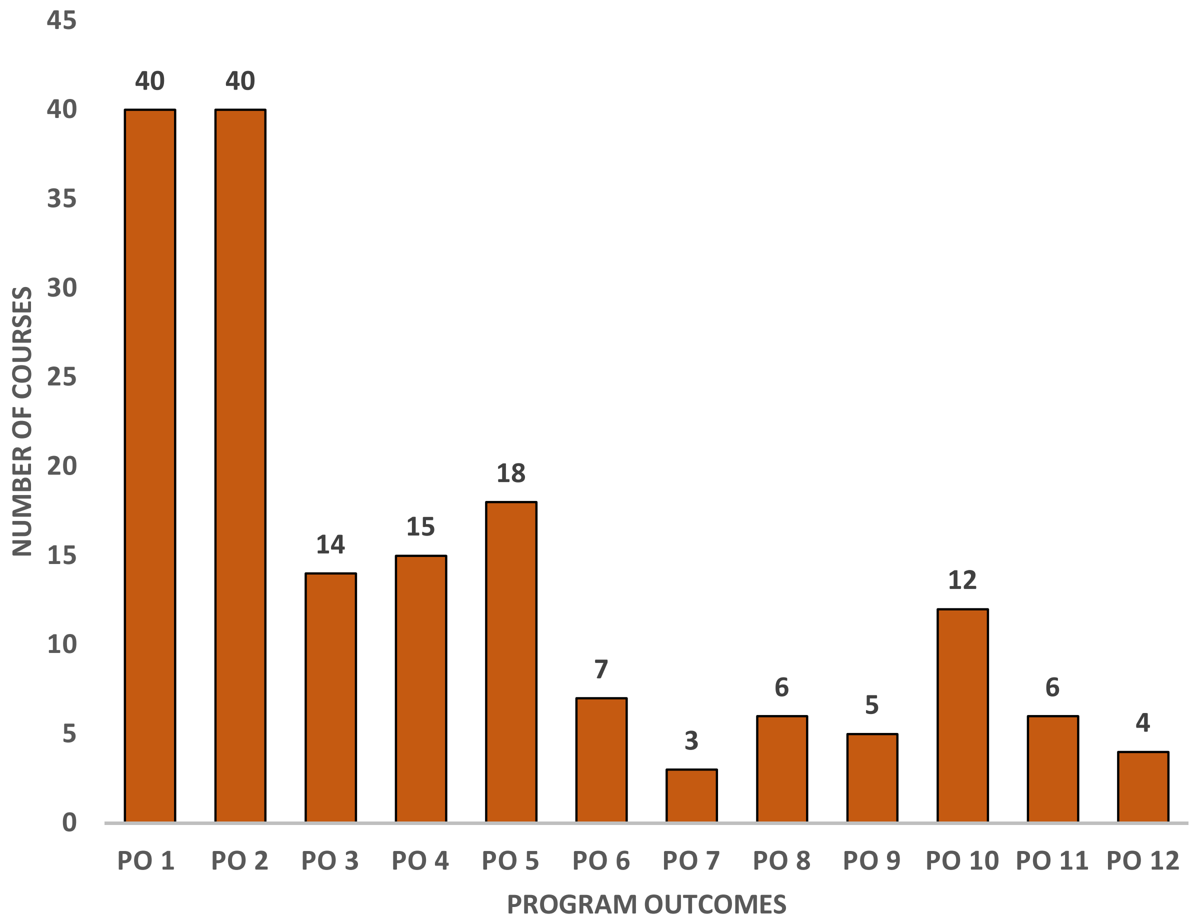
7.5 Bloom Taxonomy at a Glance



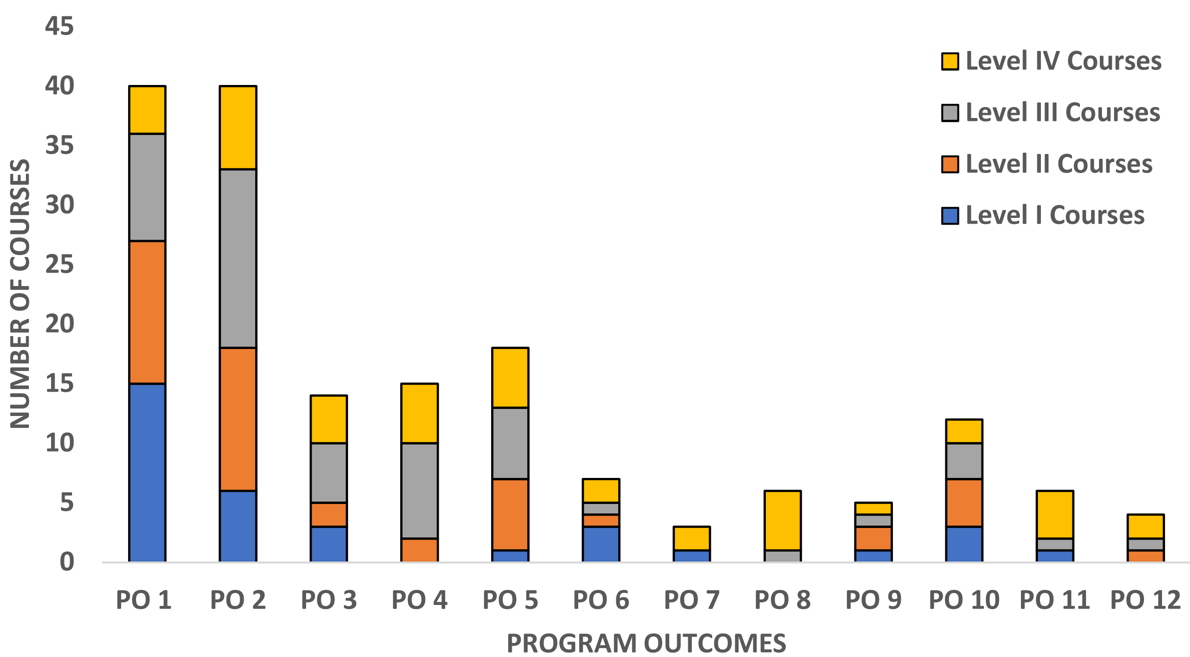
**Ref: tips.uark.edu*

CHAPTER 8
ANNEX-B

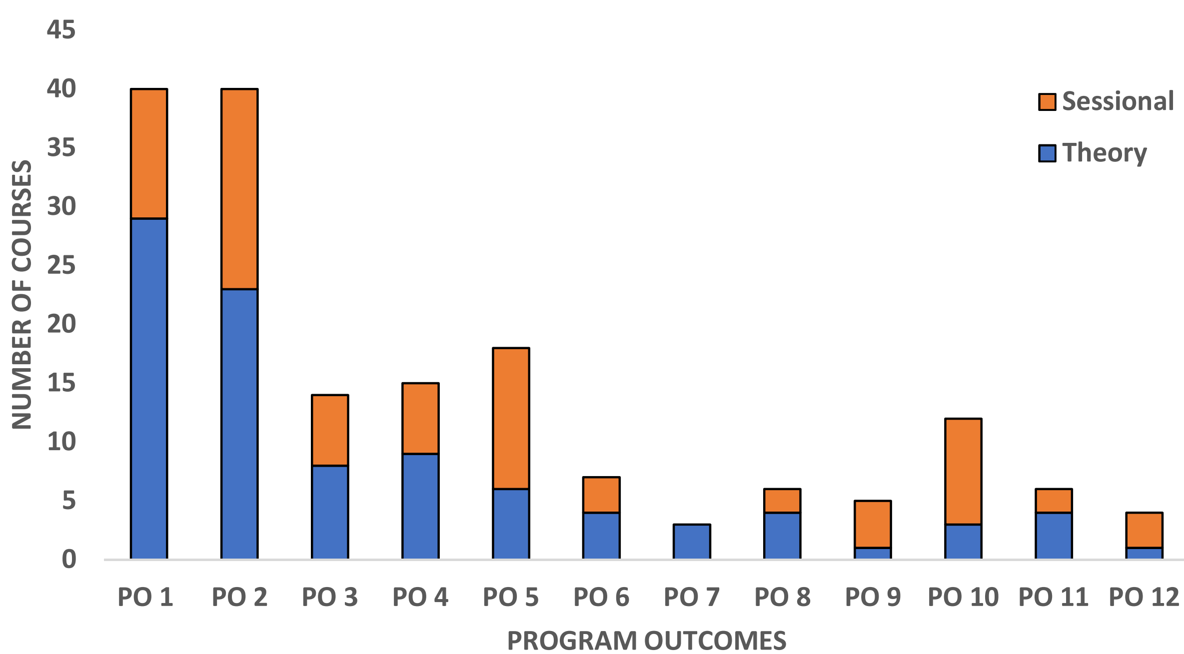
8.1 CO-PO Mapping for Entire Program



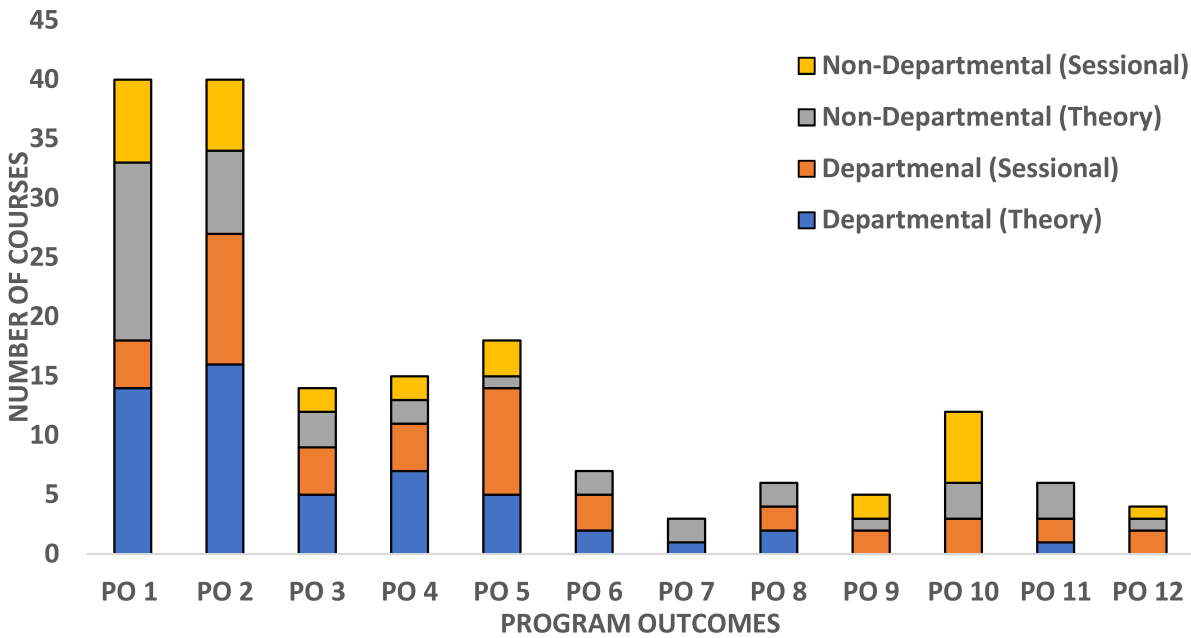
8.2 CO-PO Mapping by Different Levels



8.3 CO-PO Mapping for Sessional and Theory



8.4 CO-PO Mapping for Departmental & Non-Departmental Courses



8.5 CO-PO Mapping for Non-Departmental Courses