MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY (MIST)

SYLLABUS FOR

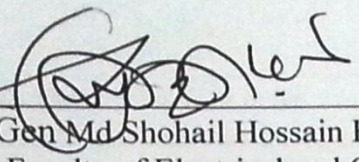
BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

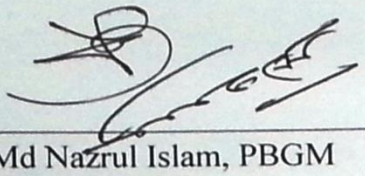
DEPARTMENT OF BIOMEDICAL ENGINEERING (BME)

JANUARY 2017
(Revised on January 2017, Applicable for BME-3 & onwards)

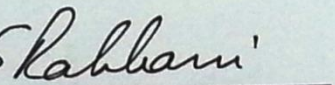
COMMITTEE FOR SYLLABUS REVIEW – BME DEPT, MIST

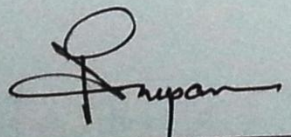
The proposed syllabus of the department of Biomedical Engineering (BME), of Military Institute of Science and Technology (MIST) has been reviewed by the committee as mentioned below. The updated syllabus is recommended for implementation from academic year 2016-17 and onwards.

1. 
Brig Gen Md Shohail Hossain Khan, psc
Dean, Faculty of Electrical and Computer Engineering
Military Institute of Science and Technology

2. 
Col Md Nazrul Islam, PBGM
Dean, Faculty of Science and Engineering
Military Institute of Science and Technology

3. 
Col S M Zia-Ul-Azim, afwc, psc
Head, Department of Biomedical Engineering
Military Institute of Science and Technology

4. 
Prof. Dr. K Siddique-e Rabbani
Department of Biomedical Physics and Technology
Dhaka University

5. 
Prof. Dr. Hasin Anupama Azhari, Ph.D
Chairman, Dept of Medical Physics and Biomedical Engineering
Gono Bishwabidyalay

COMMITTEE FOR SYLLABUS REVIEW – BME DEPT, MIST

The proposed syllabus of the department of Biomedical Engineering (BME), of Military Institute of Science and Technology (MIST) has been reviewed by the committee as mentioned below. The updated syllabus is recommended for implementation from academic year 2016-17 and onwards.

6. _____
Dr. Muhammad Tarik Arafat
Asst Prof, Department of Biomedical Engineering
Bangladesh University of Science and Technology

7. _____
Maj Polash Kumar Sarker, Ph.D, Sigs
Instr Cl-B, Department of Science and Humanity
Military Institute of Science and Technology

8. _____
Maj Md Amirul Islam, Ph.D, Engrs
Instr Cl-B, Department of Science and Humanity
Military Institute of Science and Technology

9. _____
Maj Md. Ashrafuzzaman, Ph.D, EME
Instr Cl-B, Department of Biomedical Engineering
Military Institute of Science and Technology

10. _____
Maj Md. Maruf Hasan, Ph.D, EME
Instr Cl-B, Department of Biomedical Engineering
Military Institute of Science and Technology

CHAPTER - 1

1. GENERAL INFORMATION.

1.1 **Introduction**. The necessity of establishing a technical institute for 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. With a view to meet the increasing demand for the development and dissemination of engineering and technological know-how, 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 and 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 on Civil Engineering. Bachelor of Science programme on Biomedical Engineering (BME) discipline has been started since 2014.

1.2 **Aim.** The aim of MIST is to conduct undergraduate courses in various disciplines of Engineering according to syllabi leading to Bachelor of Science in Engineering (B. Sc. Engineering) to be conferred by the Bangladesh University of Professional (BUP) for officers of the Armed Forces and civil students from home and abroad.

1.3 **Objectives.** The objectives of MIST are:

a. To offer the following courses with a view to meeting the increasing demands in the Armed Forces as well as in the country:

(1) Civil Engineering (CE)
(2) Computer Science and Engineering (CSE)
(3) Electrical, Electronic and Communication Engineering (EECE)
(4) Mechanical Engineering (ME)
(5) Aeronautical Engineering (AE)
(6) Naval Architecture and Marine Engineering (NAME)
(7) Biomedical Engineering (BME)
(8) Environmental Water Resources and Coastal Engineering (EWCE)
(9) Nuclear Science and Engineering (NSE)
(10) Architecture (Arch)
(11) Industrial and Production Engineering (IPE)
(12) Petroleum and Mining Engineering (PME) and
(13) Science & Humanities (Sci& Hum)

b. To produce skilled, well disciplined, self-motivated and dedicated engineers and computer professionals.

c. To make provisions for research and development and dissemination of knowledge in appropriate fields of science and technology.

1.4 **Location.** MIST is located at Mirpur Cantonment, northwest edge of the greater Dhaka city, a hub of knowledge for Bangladesh Armed Forces. Mirpur Cantonment is a small, calm and quiet education village and free from all possible pollution of a city life. A garland like lake with migratory birds, three sides with extended green fields in the summer and water bodies in the rainy season, whistling birds on the tree branches and overall bounty of nature adds to the already existing splendid academic atmosphere. Other neighboring academic institutions are National Defence College (NDC) and Defense Services Command and Staff College (DSCSC) - two international standard education centers.

1.5 **Eligibility of Students for Admission in MIST.** The students must fulfill the following requirements:

a. **Bangladeshi Students**.

(1) **SSC and HSC Examination (or Equivalent):** The applicant must have passed SSC/equivalent examination in Science Group obtaining GPA 4.00 (without fourth subject) in

the scale of 5.0 and in HSC/equivalent examination the applicant must obtain minimum total grade point 22 in five subjects (Mathematics, Physics, Chemistry, English, and Bangla) having minimum 'A' grade in Mathematics, Physics, and Chemistry.

(2) **GCE ('O' and 'A' Levels or Equivalent):** The applicant must have qualified in minimum five subjects including Mathematics, Physics, Chemistry and English Language with minimum 'B' in average in GCE 'O' Level and in 'A' level he/she must have obtained minimum 'B' in Mathematics, Physics, and Chemistry.

(3) **HSC Passing Year:** Applicant must have passed HSC/ Equivalent in the current academic year.

(4)**Sex:** Male and Female.

b. **Foreign Students.** Minimum 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.

c. **Eligibility for Written Admission Test**.

Candidates will be **short-listed** on the basis of total GPA of Mathematics, Physics, Chemistry and one-third GPA of English earned in HSC/equivalent examination. Approximately **6500 (Six thousand and Five hundred)** short listed candidates will be allowed to appear at the admission test.

All eligible candidates with GCE 'A' Levels (or equivalent) background and all eligible candidates against reserved seats (Children of Military Personnel, Children of Freedom Fighter, and Tribal Citizen) will be allowed to appear at the written admission test.

Short list of eligible candidates will be published in the MIST website (www.mist.ac.bd).

d. **Examination System**. There will be no multiple choice type questions (MCQ). Question for written test will be based on the current syllabus HSC examination-2015. The marks distribution for both units is as follows:

Ser	Module	Subject	Marks	Remarks
1.	1 (for Unit A)	Mathematics	80	Total Marks : 200Exam Duration: 3.0 hrs
2.		Physics	60	
3.		Chemistry	40	
4.		Functional English	20	
5.	2 (for Unit B)	Drawing and Architecture related topics	100	Total Marks : 200 + 100Exam Duration : 3.0 + 1.0 hrs

f. **Selection Criteria for Admission**. **Unit A (Engineering) and unit B (Architecture)**.

Written Admission Test.	75%
Total GPA of Mathematics, Physics and Chemistry of HSC/A level/equivalent examination.	15%
GPA of SSC/O level/equivalent examination (without 4th subject)	10%

All applicants must obtain 40% of allocated marks separately for question module 1 and 2. A merit list will be generated based on aggregate marks for required vacancies. **Biology at HSC/equivalent level is must for applicants of Biomedical Engineering**.

g. Application Form Submission. Application is to be submitted online through MIST website (**apply online**) by paying Tk 750 (Seven hundred Fifty) for only **UNIT A** and Tk 1050 (One thousand and Fifty) for **UNIT B**and **UNIT (A+B)** through TeleTalk Prepaid mobile phone.

Further clarification may be sought from MIST website and Admission Desk (+88-02-8000266 / +88-02-8035419 / 01556565566 / 01769023842). For any query on undergrad admission, please email to ***ugadmission@mist.ac.bd***.

1.6 **Number of Seats.** There will be TWO units namely UNIT **A** (**Engineering Program**) and UNIT **B (Architecture)** in MIST Admission Test. The departments are shown in the following table with respective units.

Ser	Unit	Department	Seats
1	**A**	Civil Engineering, Computer Science and Engineering, Mechanical Engineering, Electrical, Electronic and Communication Engineering	60 Each
2		Naval Architecture and Marine Engineering, Biomedical Engineering, Nuclear Science & Engineering and Environmental and Water Resources and Coastal Engineering,	40 Each
3		Aeronautical Engineering and Industrial Production Engineering	50 Each
4		Petroleum & Mining Engineering	30
5	**B**	Architecture	25
Total Seats (About 12% vacancy is allocated to military officers)			**555**

The total number is 555. In general about 12% 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 mention below:

Quota Allocation		
Ser	**Quota**	**Percentage**
1	Children of Military Personnel	40%
2	Children of Freedom Fighters	2%
3	Tribal Citizen	1%
4	International Students	3%

1.7 **Final Selection& Medical Checkup**. Students will be selected on the basis of results of the admission test. Individual choice for p of departments will be given preference as far as possible. In case of tie in the result of admission test, difference will be judged on the basis of marks obtained in Mathematics, Physics, Chemistry and English respectively in admission test.

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.

1.8 **Students Withdrawal Policy**.

1.8.1 **For Poor Academic Performance**. In all the Engineering Degree programs, it is expected that all military and civil 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. Military students failing in three or more courses/subjects in any level comprising of two regular terms will be withdrawn from the institution. Civil students will be allowed to repeat the level once, but have to complete the course within six years of registration.

b. Students failing in maximum two courses/subjects in any level, each comprising of two regular terms will be re-examined after a short term of about 6 weeks.

c. Re-examination, after short term, will be conducted at the institution before commencement of the next level.

d. Students failing in maximum one course/subject in the re-examination will be promoted to the next higher level. The failed subject will be termed as backlog subject and the students have to pass the backlog subject in the next scheduled re-examination, but without any short term. Otherwise, he/she will be withdrawn from this institution.

e. No student will be allowed to appear more than twice in the re-examinations on a particular course/subject in the whole undergraduate course.

f. Students in all levels will be allowed to appear in the re-examination on two courses/subjects including the backlog one.

g. Students repeating a level will be granted exemption for those subjects in which they earned 'B+' or better grade in the previous academic year subject to approval of the Academic Council, MIST.

h. Students will be promoted to the second term of each level, irrespective of their results in the first term of the level.

j. After Level-4, re-examination, if any military student fails in maximum one course/subject, but not the backlog subject, then he/she will leave MIST and will be allowed to appear in the next scheduled re-examination of the respective course without any short term. In that examination if he/she cannot pass the course/subject or if he/she does not appear in the referred examination within 6 years of registration will lose the scope of completing graduation. This failure will also be recorded in the dossier of military officers. Civil students will be allowed to complete the course in maximum six years.

k. 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 and repeat the whole level in the next year, subject to the approval of Academic Council, MIST.

l. In case of Bangladesh Navy student officers, if one fails, will be allowed to repeat only once in the whole programme (course) if desired by the Naval Headquarters.

m. Failure to secure/achieve a minimum GPA of 2.20 in two consecutive levels will also lead to withdrawal of the students.

1.8.2 **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:

(1) Communicating with fellow students for obtaining help in the examination.

(2) Copying from another student's script/ report /paper.

(3) Copying from desk or palm of a hand or from other incrimination documents.

(4) 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 Behaviour**. Academic Council may withdraw/expel any student on disciplinary ground if any form of indiscipline or unruly behaviour is seen in him/her which may disrupt the academic environment/programme 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. In case of withdrawal/expulsion, the matter will be referred to the Academic Council, MIST for post-facto approval.

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

CHAPTER - 2

THE DEPARTMENT OF BIOMEDICAL ENGINEERING (BME)

2.1 **Introduction**. Biomedical Engineering (BME) is the application of engineering principles and design concepts to medicine and biology for healthcare purposes e.g. diagnostic or therapeutic. This field seeks to close the gap between engineering and medicine. It combines the design and problem solving skills of engineering with medical and biological sciences to advance healthcare treatment, including diagnosis, monitoring, and therapy. The new generation of biomedical engineers is encouraged to undertake research and development activities in the above areas and this department is committed to the study and analysis of fundamental as well as applied problems. Problems of military and national importance have consequently received great emphasis in the activities of this department. In addition to the above in future there will be opportunity for postgraduate studies and research leading to a higher degrees i.e. M. Sc. (Engg), M. Engg, and Ph.D in the related fields.

2.2 **Laboratory Facilities of the Department**. The department endeavors to provide its faculty members and students adequate laboratory, library and other facilities. Departmental undergraduate courses are laboratory intensive and these requirements catered by following laboratories:

a. Electrical Circuit Laboratory
b. Electrical Circuit Simulation Laboratory
c. Computer Programming Laboratory
d. Electrical Machine Laboratory
e. Biomedical Engineering Design Laboratory
f. Biomedical Engineering Teaching Laboratory
g. Biomedical Instrumentation and Measurement Laboratory
h. Digital Signal Processing Laboratory
j. Biomaterials Laboratory
k. Microprocessor and Interfacing Laboratory
l. Biomedical Control System Laboratory
m. Biomechanics Laboratory
n. Electro-medical Equipment Laboratory
p. Biomedical Image Processing Laboratory
q. Molecular Modeling Laboratory
r. Artificial Brace and Limb Development Laboratory
s. Drug Development and Biomedicine Laboratory
t. Cell and Tissue Engineering Laboratory
u. Molecular Biology Laboratory
v. Medical Implants Laboratory

Students in Level 1 (freshman) and Level 2 (sophomore) have to undertake laboratory classes in Physics, Chemistry, English, Computer Science, Mechanical and Civil Engineering too. If necessary undergraduate students can access the facilities of other departments and centers during project, thesis and research works.

CHAPTER - 3

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAMME

3.1 **Number of Terms in a Year (Level).** There will be two regular terms (Term I and Term II) in an academic year. Those who will not be able to clear all the subjects will require appearing in the re-examination after a short term of about 6 weeks and fulfilling the other conditions as per policy.

3.2 **Duration of Terms.**The duration of each of term will be as follows:

Events	Durations			Remarks
	Academic	Others	Total	
Classes	7 weeks			
Mid Term Vacation		1 week		
Classes (7 weeks minimum),	7 Weeks			
Makeup and Preparatory Leave		2 weeks		
Term Final Examination	2 weeks			
Term End Vacation		2 weeks		May Change
Total	16 weeks	5 weeks	**21 weeks**	

The duration for referred examination will be as follows:

Short term/ Preparatory Leave	* 6 weeks	* Duration may vary depending on the situation.
Examination	1 weeks	
Total	**7 Weeks**	

3.3 **Course Pattern and Credit Structure.** The undergraduate program is covered by a set of theoretical courses along with a set of laboratory courses to support them.

3.3.1 **Course Designation System.** Each course is designated by a two to four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

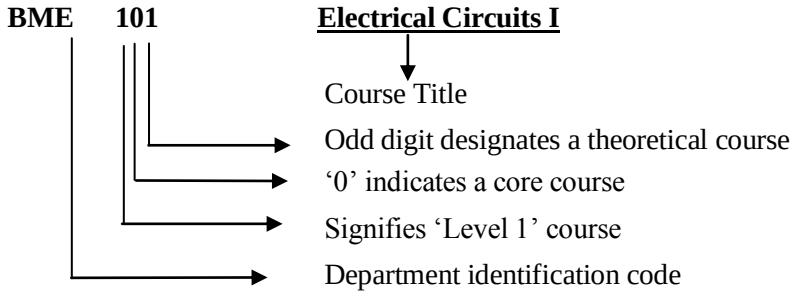
a. The first digit corresponds to the year/level in which the students normally take the course.

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

- 0 or 1 - Core courses
- 2 or 9 - Interdisciplinary
- 3 or 4 - Communication Group
- 5 or 6 - Electronics Group
- 7 or 8 - Power Group

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

d. The course designation system is illustrated as follows:



3.3.2 **Assignment of Credits .** The assignment of credits to theoretical course is different from that of laboratory course, which is stated as follows:

a. For theoretical courses one lecture per week per term is equivalent to one credit.

b. For laboratory courses two class hours per week per term is equivalent to one credit.

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

3.3.3 **Types of Courses .** The 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 the entire designated core courses of his/her discipline.

b. **Elective Courses.** Apart from the core courses, the students can choose from a set of elective courses. There are total eight elective courses as mentioned in Para 6.2 Choice of elective courses are as following:

(1) Three from individual group
(2) The rest two from individual group or other groups or interdisciplinary group or combination of these groups.

3.4 **The Grading System.**

3.4.1 **The Letter Grade.** 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 evaluation, class participation, homework, assignment and a term final examination. The assessment in laboratory courses is made by evaluating performance of the student at work during the class, viva-voce during laboratory hours and quizzes. Each course has a certain number of credits, which describes its corresponding weightages. A letter grade with a specified number of grade points is awarded in each course for which a student is registered. 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. 160.0 credits have to be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be awarded in accordance to the provisions shown below:

Grade	Grade Points	Numerical Markings
A+	4.0	80% and above
A	3.75	75% to below 80%
A-	3.50	70% to below 75%
B+	3.25	65% to below 70%
B	3.00	60% to below 65%
B-	2.75	55% to below 60%
C+	2.50	50% to below 55%
C	2.25	45% to below 50%
D	2.00	40% to below 45%
F*	0.00	Below 40%
X	-	Continuation (For project/ thesis)

* Subject in which the student gets 'F' grades will not be counted towards credit hours requirements and for the calculation of Grade Point Average (GPA)

3.4.2 **Distribution of Marks.** Thirty percent (30%) of marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments, class evaluation and class participation. The rest of the marks will be allotted to the term final examination that is conducted centrally by the Dhaka University. There are internal and external examiners for each course in the term final examination of 3-hour duration. Distribution of marks for a given course is as follows:

Class Participation/Observation	10%
Class Attendance	10%
Homework assignment and quizes	20%
Final Examination (3 hours)	60%
Total	100%

Basis for awarding marks for class participation and attendance will be as follows:

	Marks
90% and above	10
85% to less than 90%	9
80% to less than 85%	8
75% to less than 80%	7
70% to less than 75%	6
65% to less than 70%	5
60% to less than 65%	4
Below 60%	0

The number of quizzes of a course shall be n+1, where n is the number of credits of the course. Evaluation of performance in quizzes will be on the basis of the best n quizzes. The scheme of continuous assessment that a particular teacher wishes to follow for a course will be announced on the first day of classes.

3.4.3 **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 $C_1, C_2, \dots, C_n$ and his grade points in these courses are $G_1, G_2, \dots, G_n$ respectively then

$$GPA = \frac{\sum_{i=1}^{n} C_i * G_i}{\sum_{i=1}^{n} C_i}$$

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 $TC_1, TC_2, \dots, TC_n$ and his GPA in these terms are $GPA_1, GPA_2, \dots, GPA_n$ respectively then

$$CGPA = \frac{\sum_{i=1}^{n} TC_i * GPA_i}{\sum_{i=1}^{n} TC_i}$$

A Numerical Example

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

Course	Credits, C_i	Grade	Grade Points, G_i	$Ci*G_i$
EECE 101	3.00	A-	3.50	10.500
EECE 102	1.50	A+	4.00	6.000
EECE 103	3.00	A	3.75	11.250
EECE 104	1.50	B+	3.25	4.875
Phy 111	3.00	B-	2.75	8.250
Phy 112	1.50	C+	2.50	3.750
Chem 111	3.00	D	2.00	6.000
Chem 112	1.50	C	2.25	3.375
Math 111	3.00	B	3.00	9.000
Total	**21.00**			**63.000**

GPA = 63.000/21.00 = 3.00

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

Level	Term	Credit Hours Earned, TC_I	GPA Earned, GPA_i	GPA_i*TC_i
1	1	21.00	3.73	78.330
1	2	20.50	3.93	80.565
2	1	19.75	3.96	78.210
2	2	20.25	4.00	81.000
Total		**81.50**		**318.105**

CGPA = 318.105/81.50 = 3.90

3.4.4 **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 other discipline is 2.20.

3.5 **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 for any reason 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).

CHAPTER - 4

COURSE REQUIREMENT FOR THE UNDERGRADUATE STUDY OF BIOMEDICAL ENGINEERING

4.1 **Introduction**. Biomedical Engineering (BME) is the application of engineering principles and design concepts to medicine and biology for healthcare purposes e.g. diagnostic or therapeutic. This field seeks to close the gap between engineering and medicine. It combines the design and problem solving skills of engineering with medical and biological sciences to advance healthcare treatment, including diagnosis, monitoring, and therapy. The list of courses offered to the undergraduate students of Biomedical Engineering (BME) is categorized into Core courses and Elective courses. Some of the core courses are offered by the Department of BME and some by other departments. 4 elective courses from the offered list have to be completed by the student in their 4^{th} level. Each elective course will have 3.0 credit hour lecture.

4.2 **BME Courses**. The students have to complete all the core courses listed below:

4.2.1 **List of Core Courses – BME**.

Ser	Course Number	Course Name	Credit Hour
1.	BME 101	Introduction to Biomedical Engineering	3.0
2.	BME 103	Introduction to Living Cells and Human Anatomy	3.0
3.	BME 106	CAD in Biomedical Engineering Sessional	1.5
4.	BME 201	Bioelectricity	3.0
5.	BME 203	Biofluid Mechanics and Heat Transfer	3.0
6.	BME 204	Biofluid Mechanics and Heat Transfer Sessional	1.5
7.	BME 205	Human Physiology	3.0
8.	BME 206	Human Physiology 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	Principles of Diagnostic and Therapeutic Equipment	3.0
12.	BME 303	Biomaterials	3.0
13.	BME 305	Biomechanics	3.0
14.	BME 306	Biomaterials and Biomechanics Sessional	1.5
15.	BME 308	Biomedical Engineering Design-I Sessional	1.5
16.	BME 309	Embedded Systems and Interfacing	3.0
17.	BME 310	Embedded Systems and Interfacing Sessional	1.5
18.	BME 311	Medical Imaging	3.0
19.	BME 312	Medical Imaging Sessional	1.5
20.	BME 314	Industrial Training / Attachment	1.5
21.	BME 401	Physiological Control Systems	3.0
22.	BME 402	Physiological Control Systems Sessional	1.5

23.	BME 403	Molecular Biology for Engineers	3.0
24.	BME 405	Motion Analysis and Rehabilitation Engineering	3.0
25.	BME 406	Motion Analysis and Rehabilitation Engineering Sessional	1.5
26.	BME 407	Hospital Planning and Management	3.0
27.	BME 409	Professional Ethics	3.0
28.	BME 411	Biomedical Transport Fundamentals	3.0
29.	BME 412	Biomedical Engineering Design-II Sessional	1.5
33.	BME 400	Project/ Thesis	6.0
		Total	**75.0**

4.2.2 **List of Courses –Science and Humanities**.

Ser	Course Number	Course Name	Credit Hour
1.	PHY 191	Waves and Oscillations, Optics and Thermal Physics	3.0
2.	PHY 192	Physics Sessional	1.5
3.	MATH 191	Calculus	3.0
4.	CHEM 191	Organic & Inorganic Chemistry	3.0
5.	CHEM 192	Organic & Inorganic Chemistry Sessional	1.5
6.	HUM 191	English	3.0
7.	HUM 192	English Skills Sessional	1.5
8.	PHY 193	Structure of Matter, Modern Physics and Mechanics	3.0
9.	MATH 193	Complex Variables and Linear Algebra	3.0
10.	CHEM 193	Physical Chemistry	3.0
11.	CHEM 194	Physical Chemistry Sessional	1.5
12.	MATH 291	Differential Equations	3.0
13.	HUM 291	Economics	2.0
14.	CHEM 291	Biochemistry	3.0
15.	MATH 293	Probability & Statistics	3.0
16.	HUM 391	Sociology	2.0
		Total	**40.0**

4.2.3 **List of Courses –EECE**.

Ser	Course Number	Course Name	Credit Hour
1.	EECE 191	Electrical Circuits	3.0
2.	EECE 192	Electrical Circuits Sessional	1.5
3.	EECE 291	Electronic Devices and Circuits	3.0
4.	EECE 292	Electronic Devices and Circuits Sessional	1.5
5.	EECE 293	Electrical Machines	3.0
6.	EECE 294	Electrical Machines Sessional	1.5
7.	EECE 391	Digital Electronics	3.0
8.	EECE 392	Digital Electronics Sessional	1.5
9.	EECE 393	Digital Signal Processing	3.0
10.	EECE 394	Digital Signal Processing Sessional	1.5
11.	EECE 395	Random Signals & Processes	3.0
12.	EECE 397	Solid State Devices	3.0
		Total	**28.5**

4.2.4 **List Core Courses – CSE**.

Ser	Course Number	Course Name	Credit Hour
1.	CSE 291	Computer Programming	3.0
2.	CSE 292	Computer Programming Sessional	1.5
		Total	**4.5**

4.2.5 **BME Elective Courses (at least TWO elective courses must be taken from each group)**.

Group-I (Biomechanics and Biomaterials)

Ser	Course Number	Course Name	Credit Hour
1.	BME 413	Nanotechnology in Biomedicine	3.0
2.	BME 415	Artificial Organ Development	3.0
3.	BME 417	Drug Development and Delivery Systems	3.0
4.	BME 419	Tissue Engineering	3.0
5.	BME 421	Advanced Biofluid Mechanics	3.0

Group-II (Biosystems, Imaging and Instrumentation)

Ser	Course Number	Course Name	Credit Hour
1.	BME 423	Modeling of Physiological System	3.0
2.	BME 425	Biomedical Equipment & Device Development	3.0
3.	BME 427	Bioinformatics	3.0
4.	BME 429	Neuroscience and Neural Engineering	3.0
5.	BME 431	Medical Optics	3.0
6.	BME 433	Advanced Biomedical Signal Processing	3.0
7.	BME 435	Equipment in Radiology and Radiotherapy	3.0
8.	BME 437	Nuclear Medicine	3.0

4.2.6 **Summery of the Credit Hour Requirement.** To get B.Sc. Engineering degree in Biomedical Engineering (BME) following credits are to be earned:

Ser	Courses	Credit Hour
1.	BME Dept Core Courses	75.0
2.	BME Dept Elective Courses	12.0
3.	Courses to be offered by Sci & Hum Dept	40.0
4.	Courses to be offered by EECE Dept	28.5
5.	Courses to be offered by CSE Dept	4.5
	Total	**160.0**

SUMMARY OF COURSES

Ser	Department	Total Credit Hour	Theory	Sessional
1.	BME (Core Courses)	75.0	57.0	18.0
2.	BME (Elective Courses)	12.0	12.0	_
3.	Sci & Hum	40.0	34.0	6.0
4.	EECE	28.5	21.0	7.5
5.	CSE	4.5	3.0	1.5
	Total	**160.0**	**127.0**	**33.0**

CHAPTER - 5

5.1 Term wise Distribution of Courses .

5.1.1 Level-1 Term-I.

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME 101	Introduction to Biomedical Engineering	3	3.0
2.	PHY 191	Waves and Oscillations, Optics and Thermal Physics	3	3.0
3.	PHY 192	Physics Sessional	3	1.5
4.	MATH 191	Calculus	3	3.0
5.	CHEM 191	Organic & Inorganic Chemistry	3	3.0
6.	CHEM 192	Organic & Inorganic Chemistry Sessional	3	1.5
7.	HUM 191	English	3	3.0
8.	HUM 192	English Skills Sessional	3	1.5
Total			**24**	**19.5**

5.1.2 Level-1 Term-II.

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME-103	Introduction to Living Cells and Human Anatomy	3	3.0
2.	PHY 193	Structure of Matter, Modern Physics and Mechanics	3	3.0
3.	MATH 193	Complex Variables and Linear Algebra	3	3.0
4.	CHEM 193	Physical Chemistry	3	3.0
5.	CHEM 194	Physical Chemistry Sessional	3	1.5
6.	EECE 191	Electrical Circuits	3	3.0
7.	EECE 192	Electrical Circuits Sessional	3	1.5
8.	BME-106	CAD in Biomedical Engineering Sessional	3	1.5
Total			**24**	**19.5**

5.1.3 **Level-2 Term-I.**

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME-201	Bioelectricity	3	3.0
2.	MATH 291	Differential Equations	3	3.0
3.	EECE 291	Electronic Devices and Circuits	3	3.0
4.	EECE 292	Electronic Devices and Circuits Sessional	3	1.5
5.	BME- 203	Biofluid Mechanics and Heat Transfer	3	3.0
6.	BME- 204	Biofluid Mechanics and Heat Transfer Sessional	3	1.5
7.	CSE 291	Computer Programming	3	3.0
8.	CSE 292	Computer Programming Sessional	3	1.5
9.	HUM 291	Economics	2	2.0
Total			**26**	**21.5**

5.1.4 **Level-2 Term-II.**

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME- 205	Human Physiology	3	3.0
2.	BME- 206	Human Physiology Sessional	3	1.5
3.	CHEM 291	Biochemistry	3	3.0
4.	EECE 293	Electrical Machines	3	3.0
5.	EECE 294	Electrical Machines Sessional	3	1.5
6.	BME 207	Biomedical Instrumentation and Measurements	3	3.0
7.	BME 208	Biomedical Instrumentation and Measurements Sessional	3	1.5
8.	MATH 293	Probability & Statistics	3	3.0
Total			**24**	**19.5**

5.1.5 **Level-3 Term-I.**

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME 301	Principles of Diagnostic and Therapeutic Equipment	3	3.0
2.	EECE 391	Digital Electronics	3	3.0
3.	EECE 392	Digital Electronics Sessional	3	1.5
4.	BME 303	Biomaterials	3	3.0
5.	BME 305	Biomechanics	3	3.0
6.	BME 306	Biomaterials and Biomechanics Sessional	3	1.5
7.	EECE 393	Digital Signal Processing	3	3.0
8.	EECE 394	Digital Signal Processing Sessional	3	1.5
9.	BME 308	Biomedical Engineering Design-I Sessional	3	1.5
Total			**27**	**21.0**

5.1.6 **Level-3 Term-II.**

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME 309	Embedded Systems and Interfacing	3	3.0
2.	BME 310	Embedded Systems and Interfacing Sessional	3	1.5
3.	HUM 391	Sociology	2	2.0
4.	EECE 395	Random Signals & Processes	3	3.0
5.	EECE 397	Solid State Devices	3	3.0
6.	BME 311	Medical Imaging	3	3.0
7.	BME 312	Medical Imaging Sessional	3	1.5
8.	BME 314	Industrial Training / Attachment	¾ weeks	1.5
Total			**20**	**18.5**

BME 314 (Industrial Training / Attachment) will be conducted at any convenient time after the term end exam of term-2 for a duration of ¾ weeks as applicable or decided by the department.

5.1.7 **Level-4 Term-I.**

Ser	Course Number	Course Name	Contact Hour	Credit Hour
1.	BME 401	Physiological Control Systems	3	3.0
2.	BME 402	Physiological Control Systems Sessional	3	1.5
3.	BME 403	Molecular Biology for Engineers	3	3.0
4.	BME 405	Motion Analysis and Rehabilitation Engineering	3	3.0
5.	BME 406	Motion Analysis and Rehabilitation Engineering Sessional	3	1.5
6.	BME 4**	Elective 1	3	3.0
7.	BME 4**	Elective 2	3	3.0
8.	BME 400	Project/ Thesis	6	3.0
Total			**27**	**21.0**

5.1.8 **Level-4 Term-II.**

Ser	Course Number	Course Name	Contact Hour	Credit hour
1.	BME 407	Hospital Planning and Management	3	3.0
2.	BME 409	Professional Ethics	3	3.0
3.	BME 411	Biomedical Transport Fundamentals	3	3.0
4.	BME 412	Biomedical Engineering Design-II Sessional	3	1.5
5.	BME 4**	Elective 3	3	3.0
6.	BME 4**	Elective 4	3	3.0
7.	BME 400	Project & Thesis	6	3.0
Total			**24**	**19.5**

CHAPTER – 6

6.1 COURSES DESCRIPTION

6.1.1 LEVEL-1 TERM-I COURSE DESCRIPTION

CORE COURSE

BME 101 Introduction to Biomedical Engineering
Credit 3.0 Contact Hours 3

Introduction to Biomedical Engineering and Careers in Biomedical Engineering; Human Biology: Chemical basis of life, Brief introduction to Human anatomy and physiology.

Biomechanics: Introduction to Biomechanics: Force, Moments and Couples system; Musculo-Skeletal systems, Structures: Methods of Joints; Bio-materials and it interaction with tissue; Introduction to present-day medical measurements and relevant imaging and non imaging instruments.

Biosensors: sensors for monitoring patients, Non-invasive biosensors for measuring metabolism and biophysical transport; The molecular biology and genetics starting with the chemistry and interactions of the key molecules of life: DNA, RNA, and protein; Computational biology: Algorithms for Biomedical/clinical data analysis for diagnostic, predictive, or prognostic purposes.

NON DEPARTMENTAL COURSES

PHY 191 Waves and Oscillation, Optics and Thermal Physics
Credit 3.0 Contact Hours 3

Waves and Oscillations: Differential equation of simple harmonic oscillator, Total energy, average energy and combination of simple harmonic oscillations, Spring mass system, Torsional pendulum; Two body oscillation, Reduced mass, Damped oscillation, Forced oscillation, Resonance; Progressive wave, Power and intensity of wave, Stationary wave, Group and phase velocities.

Optics: Interference of light: Young's double slit experiment, Displacement of fringes and its uses, Fresnel Bi-prism, Interference in thin films, Newton's rings, Interferometers; Diffraction of light: Fresnel and Fraunhoffer diffraction, Diffraction by single slit, Diffraction from a circular aperture, Resolving power of optical instruments, Diffraction at double slit and N-slits, Diffraction grating; Polarization: Production and analysis of polarized light, Brewster's Law, Malus Law, Polarization by double refraction, Nicol prism, Optical activity, Polarimeters.

Thermal Physics: Kinetic theory of gases, Maxwell's distribution of molecular speeds, Mean free path, Equipartition of energy, Brownian motion, van der Waal's equation of state, First Law of Thermodynamics and its application, Reversible and irreversible processes, Second Law of thermodynamics, Carnot cycle, Efficiency of heat engines, Carnot’s theorem, Entropy and disorder, Thermodynamic functions, Maxwell relations, Clausius- Clapeyron equation.

PHY 192 Physics Sessional
Credit 1.5 Contact Hours 3

MATH 191 Calculus
Credit 3.0 Contact Hours 3

Differential Calculus: Limits, continuity and differentiability. Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem, Mean value theorem, Taylor's and Maclaurin's theorems in finite and infinite forms. Expansion of functions. Evaluation of indeterminate forms by L'Hospital's rule. Partial differentiation, Euler's theorem. Tangent and Normal. Subtangent and subnormal in Cartesian and polar coordinates. Determination of maximum and minimum values of functions with applications. Curvature. Asymptotes.

Integral Calculus: Integration by the method of substitution. Integration by parts, Standard integrals. Integration by successive reduction. Definite integrals, its properties and use in summing series. Walli's formulae. Improper integrals. Beta function and Gamma function. Area under plane curves and area of a region enclosed by two curves in Cartesian and polar coordinates. Volume and surface area of solids of revolution.

CHEM 191 Organic and Inorganic Chemistry
Credit 3.0 Contact Hours 3

Structure of the atom: Particle and wave nature of light, light and other form of electromagnetic radiation, atomic spectra, Bohr model, quantum numbers, atomic orbitals; Periodic table: Periodic table, atomic radius, ionization energy, electron affinity, electronegativity.

Chemical bonding: Different types of bonding, details of covalent bonding, valence bond theory (VBT), molecular geometry, Valence Shell Electron Pair Repulsion (VSEPR) theory, hybridization of orbital, molecular orbital theory (MOT). Basic concepts of oxidation and reduction reaction.

Crystal structure, Ionic solid, Lattice, unit cell, Chemistry of hydrocarbons, Synthetic methods of common organic compounds, Reaction mechanism of typical organic reactions, Structure determination of organic compounds, Basic chemistry of biomolecules.

CHEM 192 Organic and Inorganic Chemistry Sessional
Credit 1.5 Contact Hours 3

HUM 191 English
Credit 3.0 Contact Hours 3

Introduction; Importance and Mastering various approaches to learning English; Phonetics - Phonetic systems, correct English pronunciation; Grammatical problems – Grammar and usages; Approaches to communication - communication today, business communication; Methods of Writing - business letter, tenders and quotations, resumes and job letters.

Comprehension, paragraph writing, précis writing, amplification; Report Writing – Purpose of a report, classification of reports, organizing a report, writing short report, preparing complete analytical report, analysis and illustration of a report, problems in writing reports; journal articles, technical and scientific presentation.

HUM 192 English Skills Sessional
Credit 1.5 Contact Hours 3

Grammar: Tense; Article; Preposition; Subject Verb Agreement; Clause; Conditional and Sentence Structure; Vocabulary Building: Correct and Precise Diction; Affixes; Level of Appropriateness; Colloquial and Standard; Informal and Formal; Developing Reading Skill: Strategies of Reading– Skimming, Scanning, Predicting, Inferencing; Analysis and Interpreting Variety of Texts; Practicing Comprehension From Literary and Non Literary Texts; Developing Writing Skill: Introduction to syntax; Clarity and Correctness of Sentences; Linking Sentences to Form Paragraphs; Writing Paragraphs, Essays, Reports; Formal and Informal Letters; Listening Skill and Note Taking: Listening to Recorded Texts and Class Lectures and Learning to Take Useful Notes Based on Listening; Developing Speaking Skill: Oral Skills Including Communicative Expressions For Personal Identification; Life at Home; Giving Advice and Opinion; Instructions and Directions; Requests, Complaints, Apologies; Describing People and Places; Narrating events.

6.1.2 LEVEL-1 TERM-II COURSE DESCRIPTION

CORE COURSES

BME 103 Introduction to Living Cells and Human Anatomy
Credit 3.0 Contact Hours 3

Human cells: Different types of tissues and their functions.
Musculoskeletal System: Bones & joints; Classification of bones, Characteristic features, structures and compositions for different types of bones, Regional bones: Thorax, extremities head-neck, vertebral column, Classification of joints with peculiarities and functions, Regional joints, Arches of foot. Muscle; Classifications of muscles, Functions of different types of muscles, Difference among different types of muscles, Classification of skeletal muscles, Regional muscles.

Mediastinum: Circulatory System; Location of heart, Gross feature of different chambers of heart, Circulation within heart, Blood vessels and veins with their applied aspects, Location and characteristics of lymphatic system, Respiratory System; Gross features and functions of lungs and pleura, Gross features and functions of bronchial tree, Applied aspects for biomedical engineering, Elementary System; Gross features and functions of elementary system, Difference in functions among different parts of elementary system, Applied aspects for biomedical engineering, Urinary System; Gross features and functions of urinary system, Difference in functions among different parts of urinary system.

Reproductive System: Female and male reproductive organs and their functions.
Cranial Cavity: Features of cranial cavity and their contents, Contents of vertebral canal and orbit.
Nervous System: Brain, different regions of brains and their functions, Spinal cord: beginning, termination and supports, Cranial nerves, Meninges: Different parts of meninges, their components and spaces in between, Ear & Eye Ball. Integumentary System; Endocrine System.

BME 106 CAD in Biomedical Engineering Sessional
Credit 1.5 Contact Hours 3

Designing Biomedical systems using different commercial software packages.

NON DEPARTMENTAL COURSES

PHY193 Structure of Matter, Modern Physics and Mechanics
Credit 3.0 Contact Hours 3

Structure of matter : 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, bonds in solids, inter-atomic distances, calculation of cohesive and bonding energy; introduction to band theory: distinction between metal, semiconductor and insulator.

Modern physics: Michelson-Morley's experiment, Galilean transformation, special theory of relativity and its consequences; quantum theory of radiation; photo-electric effect, Compton effect, wave particle duality, interpretation of Bohr's postulates, radioactive disintegration, properties of nucleus, nuclear reactions, fission, fusion, chain reaction, nuclear reactor.

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 Fluid Mechanics, pressure, measuring pressure, Pascal's & Einstein's principle of fluid pressure, viscosity, laminar flow, turbulence, equation of continuity, Bernoulli's equation, Introduction to Quantum Mechanics, Wave function, Uncertainity principle, Postulates of Quantum Mechanics, Schrödinger time independent equation, Expectation value, Probability, Particle in a zero potential, Calculation of energy.

MATH 193 Complex Variables and Linear Algebra
Credit 3.0 Contact Hours 3

Complex Variables: Complex number system. General functions of a complex variable. Limits and continuity of functions of complex variables and related theorems. Complex differentiation and the Cauchy-Riemann equations. Infinite series & their convergence. Line integral of complex functions. Cauchy's integral formula. Liouville's theorem. Taylor's and Laurent's theorem. Singular points. Residue, Cauchy's residue theorem.

Linear Algebra: Definition of matrices. Inverse matrix; Eigen Value and Eigen Vector; Application of matrix in system of linear algebra. Vector space and its basis and dimension. Linear Transformations; Kernel and range of linear transformations.

CHEM 193 Physical Chemistry
Credit 3.0 Contact Hours 3

General concepts: Stoichiometry, properties of gas, liquid and solid, gas laws; Solution: Types of solution, properties of solution, Raoults' law, colligative properties.

Electrochemistry: Conductance and electrical properties of solution, electrolytic cell, voltaic cell, commercial batteries, Fuel-cell.

Chemical Kinetics: Rate law, rate constant, order, molecularity, first order and second order reaction, Arrhenius equation, theories of reaction rate.

Thermochemistry and basic thermodynamics. Equilibria: Phase equilibria, chemical equilibria, acid-base equilibria, ionic equilibria.

CHEM 193 Physical Chemistry Sessional
Credit 3.0 Contact Hours 3

EECE 191 Electrical Circuits
Credit 3.0 Contact Hours 3

Laws of electric circuit: Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation. Electrical networks: network analysis methods of branch and loop currents, method of node pair voltages, Thevenin's and Norton's theorems, superposition theorems. Magnetic quantities and variables: Flux, permeability and reluctance, magnetic field strength, magnetic potential, flux density, magnetization curve. Laws in magnetic circuits: Ohm's law and Ampere's circuital law. Magnetic circuits: Series, parallel and series-parallel circuits.

General concepts and definitions. Instantaneous current, voltage and power, R-, L-, C-, RL-, RC- and RLC- branches, Effective current and voltage: average values, form factor, crest factor, power real and reactive. Introduction to vector algebra. Impedance in polar and Cartesian forms. Sinusoidal single phase circuit analysis. Impedance in series, parallel branches, series-parallel circuits. Network analysis – Thevenin's theorem. Balanced poly phase circuits: three phase, four wire system of generated emfs,

three phase, three wire systems, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three phase circuit analysis and power measurement.

EECE 192 Electrical Circuits Sessional
Credit 3.0 Contact Hours 3

6.1.3 LEVEL-2 TERM-I COURSE DESCRIPTION

CORE COURSES

BME 201 Bioelectricity
Credit 3.0 Contact Hours 3

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, macroscopic channel kinetics, channel statistics, introduction to the Hodgkin-Huxley membrane model;

Action potentials: observing action potentials, nonlinear membrane behavior, origin of action potential, resting and peak voltages, voltage and space clamp, Hodgkin-Huxley equations, simulation of membrane action potential, action potential characteristics, active transport, calcium channels and "other" membrane models; impulse propagation: core-conductor model, cable equations, local circuit currents during propagation, mathematics of propagating action potentials, propagation velocity constraint for uniform fiber, propagation in myelinated nerve fibers; electrical stimulation of excitable tissue: linear (subthreshold) response of a single spherical cells, linear (subthreshold) response of a cylindrical fiber; extracellular fields: basic formulation, lumped fiber source models; cardiac electrophysiology, electrical nature of intercellular communication, source models, ECG measurement and analysis.

The Neuromuscular junction: structure of the neuromuscular junction, evidence for the quantal nature of transmitter release, Poisson statistics for transmitter release, the effect of Ca2+ and Mg2+ on transmitter release, post-junctional response to transmitter; skeletal muscle: muscle structure, muscle contraction, structure of the myofibril, sliding filament theory, Excitation-contraction, EMG measurement and analysis; neural electrophysiology: structure of the nervous system, sensory transducers and neurons, neural synapses, excitation and inhibition, neural coding and computation, EEG measurement and analysis, brain-computer interfaces; Functional electrical stimulation: electrodes and electrode-tissue behavior, nerve excitation.

BME 203 Biofluid Mechanics and Heat Transfer
Credit 3.0 Contact Hours 3

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, Thermal regulation of human body; Theoretical determination of thermal properties for biomaterial and experimental techniques; Temperature measuring devices; Different approaches in bioheat transfer modeling.

BME 204 Biofluid Mechanics and Heat Transfer Sessional
Credit 1.5 Contact Hours 3

NON DEPARTMENTAL COURSES

MATH 291 Differential Equations
Credit 3.0 Contact Hours 3

Ordinary Differential Equations: Formation of differential equations. Solution of first order differential equations by various methods. Solution of general linear equations of second and higher order with constant coefficients. Solution of homogeneous linear equations. Solution of differential equations of the higher order when dependent and independent variables are absent. Solution of differential equations by the method based on factorization of operators. Frobenius method.

Partial Differential Equations: Formation of partial differential equations. Solutions of linear and nonlinear partial differential equations of first order. Linear equations of higher order. Equations of the second order with variable coefficients. Wave equations. Particular solutions with boundary and initial conditions.

EECE 291 Electronic Devices and Circuits
Credit 3.0 Contact Hours 3

Introduction to semiconductors; p-type and n-type semiconductors; p-n junction diode characteristics; Diode applications: half and full wave rectifiers; clipping and clamping circuits; regulated power supply using zener diode. Bipolar Junction Transistor (BJT): principle of operation; I-V characteristics; Transistor circuit configurations (CE, CB, CC), BJT biasing; load lines; BJTs at low frequencies; Hybrid model, h parameters, simplified hybrid model; Small- signal analysis of single and multi-stage amplifiers; frequency response of BJT amplifier; 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 circuits using FETs; Introduction to CMOS. Operational Amplifiers (OPAMP): linear applications of OPAMPs, gain, input and output impedances; active filters; frequency response and noise.

EECE 292 Electronic Devices and Circuits Sessional
Credit 1.5 Contact Hours 3

CSE 291 Computer Programming
Credit 3.0 Contact Hours 3

Programming concepts; Program development stages; Flow charts;

Structured programming language: Data types, operators, bitwise operation, expressions, control structures: if-else, switch-case, loop (for loop, while loop, do-while loop).

Input and Output: standard input and output, formatted input and output.

Functions and program structure: Function basics, Parameter passing conventions, Scope rules, Storage classes, Recursion, Header files, Preprocessor, Pointer and its uses, Arrays, Strings, Multidimensional array;

User defined data types: structures, unions, enumerations.

File, Variable length argument list, Command line parameters, Error Handling, Linking, Library functions.

CSE 292 Computer Programming Sessional
Credit 1.5 Contact Hours 3

HUM 291 Economics
Credit 2.0 Contact Hours 2

Introduction to Economics, Economics and Engineering, The Techniques of Resource: Allocation, Micro-Economics: Theory Of Utility And Preferences, Marginal Analysis. The; Theory of Demand and Supply and their Elasticities; Price Determination Indifference Curve countries; Indifference curve technique; Marginal analysis; Production; production function; Technique; Theory of Production and Cost; Theory of the Firm and Market Structure and market Optimization; Macro-Economics: Savings, Investment, Employment; National Income Analysis; Inflation: Demand Pull and Cost Push Inflation, Stagflation, Policies for Controlling Inflation. Economics of Development and Planning.

6.1.4 LEVEL-2 TERM-II COURSE DESCRIPTION

CORE COURSES

BME 205 Human Physiology
Credit 3.0 Contact Hours 3

Definition, goal & importance of physiology. Homeostasis: definition. major functional systems, control systems of the body. Cellular Physiology and Blood .Composition and function of blood. Cardiovascular Physiology: Properties of cardiac muscle, Generation of cardiac impulse and its conduction in the heart, Cardiac cycle, heart sound. 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. Functional organization and functions of major levels of central nervous system

BME 206 Human Physiology Sessional
Credit 1.5 Contact Hours 3

BME 207 Biomedical Instrumentation and Measurements
Credit 3.0 Contact Hours 3

Principles of a medical instrumentation system, properties of biomedical instrumentation and measurements: precision, resolution, accuracy, uncertainty, sensitivity, repeatability, calibration, maintenance and reparability, principles of biomedical transducers: , bio-physical parameters: force, displacement, temperature and velocity, resistive, capacitive, inductive, optical and ultrasonic transducers; laws of membrane biophysics: electrical properties of cells and electrical equivalent model for the cell membrane; action potential, Hogkin-Huxley model, principles of electroneurogram (ENG) and electromyogram (EMG), cardiovascular measurements: anatomy of the heart, principles of electrocardiography, measurement of blood pressure and blood flow, measurement of heart rate and heart rate variability, polyplethysmography (PPG) for heart rate measurement.

Brain signal measurements: brain anatomy, electrical potential from the brain, principles of electroencephalography, brain-computer interface; therapeutic and prosthetic devices: anesthesia with ventilator, ICU ventilator, inhaler, defibrillator, pacemaker, neural simulator, respirator, heart-lung machine etc., measurement of respiratory volumes and flow, bio-potential electrodes and amplifiers: polarisation, circuit models, interface between skin and electrodes, motion artifacts techniques for noise and interference reduction, grounding shielding, safety issues in medical equipment.

BME 208 Biomedical Instrumentation and Measurements Sessional
Credit 1.5 Contact Hours 3
Hands On practice on Anesthesia with Ventilator, ICU Ventilator, Patient Monitor, Defibrillator etc.

NON DEPARTMENTAL COURSE

CHEM 291 Biochemistry
Credit 3.0 Contact Hours 3

Introduction: molecular logic of living system. Biomolecules and cells. Sugars, polysaccharides, lipids-triglycerides, phospholipids, biological membranes. Proteins: amino acid sequences, primary, secondary, tertiary and quaternary structure; classification of proteins. Enzymes mechanism: kinetics and inhibition. Nucleic acid: nucleotides. DNA, RNA composition and simple structure; replication, transcription and translation. Genetic code and genetic engineering. Vitamins and coenzymes. Digestion of polysaccharides, lipids and proteins. Metabolism and energy transfer; glycolysis and oxidative phosphorylation; biological high-energy compounds. Oxidation of fatty acids and oxidative degradation of amino acids. Photosynthetic phosphorylation. Inter relationship and control metabolism. Some inborn errors of metabolism.

EECE 293 Electrical Machines
Credit 3.0 Contact Hours 3

AC / DC Generator: Construction, Introduction to winding, Types, no-load voltage characteristics, build-up of a self excited shunt generator, critical field resistance, load-voltage characteristic, effect of speed on no-load and load characteristics and voltage regulation.

AC / DC Motor: Torque, counter emf, speed, torque-speed characteristics, starting and speed regulation. Introduction to wind turbine generators, and solar cells.

Transformer: Ideal transformer, transformation ratio, no-load and load vector diagrams. Actual transformer: Equivalent circuit, short circuit and open circuit tests, regulation and efficiency, three phase transformer.

Alternator & Induction Motor: Split phase motors, Squirrel cage induction motors, Single phase induction motors, Types of operation, equivalent circuits, Starting and Torque speed Characteristics, Special type of motors.

Turbine / Blower: Use of different motors / turbines / blowers in different medical equipments-Introduction.

EECE 294 Electrical Machines Sessional
Credit 3.0 Contact Hours 3

MATH 293 Probability and Statistics
Credit 3.0 Contact Hours 3

Measures of central tendency and variation, Chebychev's theorem, z-scores, Frequency distribution, Graphical representation of data including stem, Leaf and Box Plot, Skewness, Kurtosis. Probability theory: Rules of probability, Conditional probability, Bayes's Theorem, Counting techniques. Random Variable: Concept of random variable, Discrete and Continuous random variable, variance of random variable and their properties. Discrete and Continuous Probability Distributions: Binomial, Multinomial, Negative binomial, Normal, Poisson, Exponential, Uniform, Gamma distribution. Sampling Theory: Sampling distribution of mean, and Sampling procedures. Regression and Correlation: ANOVA. Statistical Inference: Estimation of parameters. Hypothesis Testing: z-test, t-test and Goodness of fit.

6.1.5 LEVEL-3 TERM-I COURSE DESCRIPTION

CORE COURSES

BME 301 Principles of Diagnostic and Therapeutic Equipment
Credit 3.0 Contact Hours 3

Diagnostic Equipment:
Normal and abnormal ECG waveform, diagnosis interpretation, cardiac pacemaker-external pacemaker, implantable pacemaker, different types of pacemakers, fibrillation, defibrillator, AC defibrillator, DC defibrillator, electrodes, synchronised and unsynchronised types. EEG diagnostic interpretation, recording and analysis of EMG waveforms.

Heart lung machines: Need for the unit, functioning of bubble, disc type and membrane type oxygenerators, fingerpump, roller pump, electronic monitoring of functional parameter. Spirometer, Respiratory volume measurement, pnemograph, artificial respirator – IPR type, functioning, Pulse Oximetry.

Electrical stimulators: Strength-duration curve, types of stimulators, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulator: peripheral nerve stimulator, Ultrasonic stimulators, stimulators for pain and relief. Principles of Cryogenic technique and application, Endoscopy, Laproscopy, Thermography.

Echo: Basic principles of Echo technique, display techniques A, B, M, D modes, Echo cardiograms, Echo encephalogram, Ultrasonic applied as diagnostic tool in ophthalmology, obstetrics and gynaecology. Principles of Dialysis – Hemodialysis.

Therapeutic Equipment:
Patient monitoring system – Physiological signals, (ECG, SpO2, Respiration, Temp, NIBP, IBP, etCO2, EEG, EMG, CO, NMT, BIS, CNAP), Telemetry - Single / multichannel, Network Monitoring, Central monitoring systems / Web Based Monitoring System for patient monitoring. Arrhythmia and ST analysis, Channels of Monitors.

BME 303 Biomaterials
Credit 3.0 Contact Hours 3

The Structure of Solid: Atomic bonding, crystal structure, imperfection in crystalline structures, long-chain molecular compounds (polymers), super cooled and network solids and composite material structure. Characterization of Materials: Mechanical properties, 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.

Metallic Implant Materials: 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 roperties, and various uses of biomaterials. Composites as Biomaterials: Structure,

mechanics of composites, applications of composite biomaterials, biocompatibility of composite, biomaterials. Structure Property Relationships of Biological Materials: Proteins, polysaccharides, and structure-property relationship of tissues.

BME 305 Biomechanics
Credit 3.0 Contact Hours 3

Principles of Equilibrium: Forces; moments and couples; equations of static equilibrium; structural idealization applications in biomechanics. Basics of stress and strain analysis.
Muscles and Movement: Skeletal muscle morphology; isotonic versus isometric construction; muscles constitutive modeling, whole muscle mechanics parallel versus pinnate muscle types; 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; Adaptation of Major Tissues and Organs: Planes and axes of movement, Types of muscular contraction, Load and force of contraction;

Basic Dynamics to Human Motion: Review of linear and angular kinematics; Kinetic equations of motion; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis; Introduction to Viscoelasticity.

BME 306 Biomaterials and Biomechanics Sessional
Credit 1.5 Contact Hours 3

BME 308 Biomedical Engineering Design-I Sessional
Credit 1.5 Contact Hours 3

Integrated design of medical devices following related design considerations and cost estimation.

NON-DEPARTMENTAL COURSES

EECE 391 Digital Electronics
Credit 3.0 Contact Hours 3

Introduction to number systems and 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, flip-flops and their design using ASM approach, timing analysis and power optimization of sequential circuits. Modular sequential logic circuit design: shift registers, counters and their applications.

EECE 392 Digital Electronics Sessional
Credit 1.5 Contact Hours 3

EECE 393 Digital Signal Processing
Credit 3.0 Contact Hours 3

Introduction to digital signal processing (DSP): Discrete-time signals and systems, analog to digital conversion, impulse response, finite impulse response (FIR) and infinite impulse response (IIR) of discrete-time systems, difference equation, convolution, transient and steady state response.

Discrete transformations: Discrete Fourier series, discrete-time Fourier series, discrete Fourier transform (DFT) and properties, fast Fourier transform (FFT), inverse fast Fourier transform, Z transformation - properties, transfer function, poles and zeros and inverse Z transform. Correlation: Circular convolution, auto-correlation and cross correlation.

Digital Filters: FIR filters - linear phase filters, specifications, design using window, optimal and frequency sampling methods, IIR filters – specifications, design using impulse invariant, bi-linear Z transformation, least-square methods and finite precision effects.

EECE 394 Digital Signal Processing Sessional
Credit 1.5 Contact Hours 3

6.1.6 LEVEL-3 TERM-II COURSE DESCRIPTION

CORE COURSES

BME 309 Embedded Systems and Interfacing
Credit 3.0 Contact Hours 3

Introduction to embedded systems with applications: Overview of the design flow, Embedded system specification and modeling; Introduction to embedded processors and microcontrollers: types of processors, architecture, addressing modes, instruction sets, interrupts, parallelism; Memory architectures: memory technologies, memory hierarchy, memory models; memory interface; Bus interface; I/O hardware and interface; Integrating microcontrollers with interfacing chips; Programmable peripheral interfacing chip with interface to A/D and D/A converter; Programmable interrupt controller, DMA controller; Sensor and Actuators: models of sensors and actuators, common sensors, actuators; Interfacing to the external world through sensors and actuators.

BME 310 Embedded Systems and Interfacing Sessional
Credit 1.5 Contact Hours 3

BME 311 Medical Imaging
Credit 3.0 Contact Hours 3

Introduction to imaging, medical imaging modalities, Medical imaging before x-rays, Hippocratic thermography, dissection, laproscopy, X-radiography, Computed tomography (CT), evolution of CT scanner design, image reconstruction algorithms, filtered back-projection method, iterative method, low dose computed tomography, Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications, Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI, Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI, Nuclear imaging.

BME 312 Medical Imaging Sessional
Credit 1.5 Contact Hours 3

BME 314 Industrial Training / Attachment (In Hospitals/Labs/Biomedical or Pharmaceutical companies**)**
Credit 1.5 Contact Hours ¾ Weeks

BME 314 (Industrial Training / Attachment) will be conducted at any convenient time after the term end exam of term-2 for duration of ¾ weeks as applicable or decided by the department.

NON-DEPARTMENTAL COURSES

HUM 391 Sociology
Credit 2.0 Contact Hours 2

Introduction: Society; Science and Technology an Overview; Scientific Study of Society; Social Elements; Society, Community, Association and Institution; Mode of Production and Society; Industrial Revolution, Development of Capitalism. Culture and Socialization: Culture; Elements of Culture; Technology and Culture; Cultural Lag; Socialization and Personality; Family; Crime and Deviance; Social Control. Technology, Society and Development: Industrialization and Development; Development and Dependency Theory; Sustainable Development; Development and Foreign Borrowing; Technology Transfer and Globalization, Modernity and Environment; Problem and Prospects.

Pre-Industrial, Industrial and Post-Industrial Society: Common Features of Industrial Society; Development and Types of Social Inequality in Industrial Society; Poverty, Technology and Society; Social Stratification and Social Mobility; Rural Vs Urban Life; Evaluation of City Life; Population and Society: Society and Population; Fertility, Mortality and Migration; Science, Technology and Human Migration; Theories of Population Growth - Demographic Transition Theory; Malthusian Population Theory; Optimum population Theory; Population Policy.

EECE 395 Random Signal and Processes
Credit 3.0 Contact Hours 3

Probability and Random variables: Sample space, set theory, probability measure, conditional probability, total probability, Bayes theorem, independence and uncorrelatedness. Expectation, Variance, moments and characteristic functions. Commonly used distribution and density functions. Central limit theorem. Transformation of a random variables: one, two and N random variables. Joint distribution, density, moments and characteristic functions, system reliability.

Random Processes: Correlation and covariance functions. Process measurements. Gaussian, and Poisson random processes. Markov Process**.** Noise models. Stationarity and Ergodicity. Spectral Estimation. Correlation and power spectrum. Cross spectral densities. Response of linear systems to random inputs, Optimal filters: Wiener and matched filters, Statistical Estimation Techniques (ML, MMSE, MAP).

EECE 397 Solid State Devices
Credit 3.0 Contact Hours 3

Semiconductors in equilibrium: Energy bands, intrinsic and extrinsic semiconductors, Fermi levels, electron and hole concentrations, temperature dependence of carrier concentrations and invariance of Fermi level. Carrier transport processes and excess carriers: Drift and diffusion, generation and recombination of excess carriers, built-in-field, recombination-generation SRH formula, surface recombination, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level. PN junction: Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias, carrier injection, minority and majority carrier currents, transient and AC conditions, time variation of stored charge, reverse recovery transient and capacitance.

Bipolar Junction Transistor: Basic principle of pnp and npn transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents, coupled-diode model and charge control analysis, Ebers-Moll model and circuit synthesis. Metal-semiconductor junction: Energy band diagram of metal semiconductor junctions, rectifying and ohmic contacts.
MOS structure: MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage, static C-V characteristics, qualitative theory of MOSFET operation, body effect and current-voltage relationship of a MOSFET.

6.1.7 LEVEL-4 TERM-I COURSE DESCRIPTION

CORE COURSES

BME 400 Project / Thesis
Credit 3.0 Contact Hours 6

BME 401 Physiological Control Systems
Credit 3.0 Contact Hours 3

Introduction to physiological modeling: what is a model and why model, multi-scale organization of living organisms: cell to organ Homeostasis. Examples of physiological control systems.

Tools for modeling physical systems: Review of linear systems, Laplace transform, Fourier series and Fourier transform, system response in the time and frequency domains, transfer function, open loop control, feedback control, 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.

BME 402 Physiological Control Systems Sessional
Credit 1.5 Contact Hours 3

BME 403 Molecular Biology for Engineers
Credit 3.0 Contact Hours 3

Introduces the fundamentals of cell structure and function: chemistry, organelles, enzymes, membranes, membrane transport, intracellular compartments and adhesion structures; energy flow in cells concentrates on the pathways of glycolysis and aerobic respiration; information flow in cells focuses on modern molecular biology and genetic engineering, and DNA replication, the cell cycle, gene expression, gene regulation, and protein synthesis. Cytoskeleton and signal transduction. Cancer, Cell junctions, cell adhesion and the extracellular matrix. Development of multicellular organisms. Specialized tissues and stem cells Innate immunity and adaptive immune system.

BME 405 Motion Analysis and Rehabilitation Engineering
Credit 3.0 Contact Hours 3

Rehabilitation Engineering: Impairments, disabilities and handicaps, Measurement and assessment. Characterizing engineering concepts in sensory and motor rehabilitation.Engineering concept in communication disorders. Rehabs for locomotion, visual, speech & hearing. Artificial limb and hands, prosthetic heart valves. Externally powered and controlled orthotics and prosthetics. Myoelectric hand and arm prostheses. The marcus intelligent hand prostheses, gait study, spinal rehabilitation.

BME 406 Motion Analysis and Rehabilitation Engineering Lab
Credit 1.5 Contact Hours 3

BME 4 Elective 1**
Credit 3.0 Contact Hours 3

BME 4 Elective 2**
Credit 3.0 Contact Hours 3

6.1.8 LEVEL-4 TERM-II COURSE DESCRIPTION

CORE COURSE

BME 400 Project / Thesis
Credit 3.0 Contact Hours 6

BME 407 Hospital Planning and Management
Credit 3.0 Contact Hours 3

Hospital Planning – Feasibility study, Layout planning, Introduction to Norms and standards (e.g. HBN / FGI / AHA / ICRP / JCI / FDA / CE/ ISO), methods to monitor the standards. Understanding of patient flow, OT Complex design, ICU and NICU Design, Infection Control, Modular Hospital Concept, Central Medical Gas System design, HVAC system, Requirements and design considerations. Concept of Ambulance services, Laundry services, Civil Assets, Hospital Information System, CSSD, Medical Waste Management, and Mortuary.

Clinical engineering program, role of BMEs in hospital, staff structure in hospital. Introduction to Procurement Process*. Need for evolving health policy, health organization in state, health legislation. Nature and value of strategic management in hospitals, Integration of IT in Various functions of Hospital. Application of statistical tools in the areas of Health services.

Introduction to support services - Disaster management, Fire Fighting system, Auxiliary Power Supply (Generator / UPS) etc. Elements of Safety, Safety Publications and Standards Organizations, Orientation to Laboratory Safety, PEL Standards and Calculations, Radiation hazards, Radiation detection, Safety measures, Standards, Flammables and Explosives, Material Safety, Organization of Safety in the hospitals.

* Preparation of specifications, Negotiation technique and an overview on Tendering process, Evaluating Tenders, Work order, Proforma invoice / Order confirmation, Shipping documents.

BME 409 Professional Ethics
Credit 3.0 Contact Hours 3

Definition and scope of Ethics, Different branches of Ethics, Social Change and the Emergence of New Technologies; Public Health and Public safety; Human qualities of an Engineer, Applied Ethics in Engineering: Ethical Issues in Design and Manufacturing; Risk analysis; Cost-benefit analysis; Resources Allocation; Ethical Expectations: Professional Restrictions and Professional Responsibility; Responsibilities of Biomedical Engineer; Obligation of an Engineer to the Clients, Rights of Engineers; History and Development of Engineering Ethics; Institutionalization of Ethical Conduct: The Ethics of Engineering Organizations, Professional Codes of Ethics, Negligence; Inter Professional Relationship; Conflicts of Interests.

Medical ethics, Ethical Conflicts, Bioethical Principles, The Patient-Physician Relationship, Autonomy and Privacy of Patients; Professional Conduct and confidentiality, Truth Telling, the Hippocratic Oath; Biotechnologies: Reproductive Techniques, Genetic Engineering, Clinical

Trials, Abortion, Genetic Testing Issues, Humane Experiment, Euthanasia; Protection of Human and Animal Subjects.

BME 411 Biomedical Transport Fundamentals
Credit 3.0 Contact Hours 3

Introduction to mass, momentum and heat transport in living systems; Basic hemodynamics; 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.

BME 412 Biomedical Engineering Design-II Sessional
Credit 1.5 Contact Hours 3

Construct/ develop the medical device designed in BME 310 Biomedical Engineering Design I course and test its performance.

BME 4 Elective 3**
Credit 3.0 Contact Hours 3

BME 4 Elective 4**
Credit 3.0 Contact Hours 3

6.2 Elective Courses - BME

BME 413 Nanotechnology in Medicine
Credit 3.0 Contact Hours 3

Introduction to Physics of Solid State: Intermolecular forces: thermodynamic aspects - Quantum Mechanical Treatment of the Many-Particle Problem - Potential Energy Surface - Pair Potential Approximation - Advantages and Limitations of the Pair Potential Approximation - Phenomenological Potentials - Pseudo-Potentials - Many-Body Potentials.

Fundamentals of Nano Science: Size dependence of properties - Particle size determination - Bulk to nano transition - Semiconducting nanoparticles - Carbon nanostructures - Mechanical properties (hardness, ductility, elasticity) - Optical properties of nanotubes - Electrical properties of nanotubes.

Preparation of Nano Systems: Introduction to nanolithography - Carbon nanotubes: preparation - Synthesis and preparation of nanomaterials (crystalline and thinfilm) - Physical and chemical methods - Control and stability (size, shape, composition).

Characterization of Nano Systems: Thermal Stability - Basic Material Properties - Mean Values and Correlation Functions - X-ray diffraction - Scanning Electron Microscopy - Scanning Tunneling Microscopy - Electron Microscopy - X-ray absorption spectroscopy – Photoelectron emission spectroscopy.

Applications: Potential of Nanotechnology in Medicine - Nanotubes, nanowires, and nanodevices-introduction - Functional Nanostructures – Introduction to molecular electronics - Field emission and Shielding - Microelectromechanical systems (MEMs) - Nanoelectromechanical systems (NEMs) - Molecular and Supramolecular Switches – Biosensors – Qdots – Nanoshells – Nanobiotix – Cancer detection – Drug Delivery using Nanoparticles and Molecular Carriers.

BME 415 Artificial Organ Development
Credit 3.0 Contact Hours 3

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.

BME 417 Drug Development and Delivery Systems
Credit 3.0 Contact Hours 3

This course is primarily designed to prepare students for an academic or industrial career in pharmaceutics or drug delivery. Qualified graduates are in significant demand, due to the continued development of highly complex and sensitive drug molecules. The course is based with several research modules and a specific research project. These modules cover the biology of disease states, designing drugs and delivery systems, research methods and exploiting your research. The Syllabus of this course will be followed as;

- Drug Discovery
- Chemotherapy & Selective Toxicity
- Drug Dosage Form & Design
- Principles of Product Analysis and Validation
- Drug Delivery and Targeting
- Research Methods 1: Professional Development
- Research Methods 2: Communication Skills
- Research Project

BME 419 Tissue Engineering
Credit 3.0 Contact Hours 3

Introduction: Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

Cell culture: Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

Molecular biology aspects: Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor- Ligand binding, and Cell surface markers.

Scaffold and transplant: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis.

Case study and regulatory issues: Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

BME 421 Advanced Biofluid Mechanics
Credit 3.0 Contact Hours 3

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 hemodynamics. 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.

BME 423 Modeling of Physiological System
Credit 3.0 Contact Hours 3

Approaches to Modeling: The technique of mathematical modeling, classification of models, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models.Time invariant and time varying systems for physiological modeling.

Nonparametric Modeling: Volterra models. Wiener models.Efficientvolterra kernel estimation Analysis of estimation errors. Parametric modeling: Basic parametric model forms and Estimation procedures. Volterra kernels of nonlinear differential equations.Discrete-time volterra kernels of NARMAX models. From Volterra kernel measurements to Parametric models. Equivalence between continuous and Discrete -parametric models.

Equivalent Circuit Model: Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.

Physiological Modeling: Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter

current model of urine formation, model of Henle's loop, and Linearized model of the immune response: Germ, Plasma cell, Antibody, system equation and stability criteria.

Electrical Circuit Model of Oxygenation. A model of immune response to disease (Block Diagram). Modeling of multi input/multi output systems: The Two-input case. Application s of two-input modeling to physiological systems. The multi-input case spatiotemporal and spectro-temporal modeling.

BME 425 Biomedical Equipment and Device Development

Credit 3.0 Contact Hours 3

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.

Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input.

Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

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 & IVI, image acquisition & processing, Motion Control.

Use of Analysis Tools, Fourier transforms Power spectrum, Correlation methods, windowing & flittering. Application of VI: Application in Process Control Designing of equipments like Oscilloscope, Digital Millimeter using Lab view Software, Study of Data Acquisition & control using Lab view Virtual instrumentation for an Innovative Thermal Conductivity Apparatus to measure the Thermal Conductivity Apparatus- to measure the conductivity of non Newtonian fluids white they are subjected to sharing force.

BME 427 Bioinformatics

Credit 3.0 Contact Hours 3

Introduction to algorithms and computational complexity; Basic graph theoretic terminologies; Graph algorithms: DNA sequencing, DNA fragment assembly, Spectrum graphs; Sequencesimilarity; Suffix Tree and variants with applications; Genome Alignment: maximum unique match, LCS, mutation sensitive alignments; Database search: Smith-Waterman algorithm, Fast A, BLAST and its variations, Locality sensitive hashing; Multiple sequence alignment; Phylogeny reconstruction; Phylogeny comparison: similarity and dissimilarity measurements, consensus tree problem; Genome rearrangement: types of genome rearrangements, sorting by reversal and other operations; Motif finding; RNA secondary structure prediction; Peptide sequencing; Population genetics.

BME 429 Neuroscience and Neural Engineering
Credit 3.0 Contact Hours 3

This course covers theoretical methods for analyzing information encoding and representing function in neural systems, including models of single and multiple neural spike trains based on stochastic processes and information theory, detection and estimation of behaviorally relevant parameters from spike trains, system theoretic methods for analyzing sensory receptive fields, and network models of neural systems. Both theoretical methods and the properties of specific well-studied neural systems will be discussed. This course also covers the physiology of auditory system and hearing from a model-oriented viewpoint. Topics include basilar membrane mechanics, models of cochlear transduction, stochastic process models of neural discharge, detection of theoretic approaches to relating physiological and psychological data, models of signal processing in central auditory nuclei, and nonlinear methods of characterizing neurons. Autism will also be covered.

BME 431 Medical Optics
Credit 3.0 Contact Hours 3

Optical Properties of the Tissues
Refraction, Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical-Thermal-Electromechanical – Photoabalative processes.

Instrumentation in Photonics
Instrumentation for absorption, Scattering and emission measurements, excitation light sources – high pressure arc lamp, LEDs, Lasers, Optical filters, - optical detectors – Time resolved and phase resolved detectors.

Surgical Applications of Lasers
Lasers in ophthalmology- Dermatology –Dentistry-Urology-Otolaryngology - Tissue welding.

Non Thermal Diagnostic Applications
Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and speckle application of lasers in biology and medicine.

Therapeutic Applications
Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and nononcological applications of PDT - Biostimulation effect – applications-Laser Safety Procedures.

BME 433 Advanced Biomedical Signal Processing
Credit 3.0 Contact Hours 3

Review of human anatomy and cell physiology; different types of biomedical signals: electroencephalogram (EEG), electrocardiogram (ECG), electrocorticogram (ECoG), electromyogram (EMG), electrooculogram (EOG), magnetoencephalogram (MEEG), respiratory sounds, hear sounds etc.; biomedical signal recording system: spectral characteristics of biomedical signals, bio-sensors and acquisition of biomedical signals, sampling, quantization and encoding, multi-rate systems, compressed sensing; time-domain analysis of biomedical signals; statistical analysis of biomedical signals using HOS, PCA, ICA, SVD, SSA etc. Estimation of power spectrum and correlation analysis; time-frequency domain analysis of biomedical signals: short-time Fourier transform, discrete-cosine transform (DCT), 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, applications of biomedical systems.

BME 435 Equipment in Radiology and Radiotherapy

Credit 3.0 Contact Hours 3

Linear Accelerators: Introduction of Linear Accelerators, Principles of Linear Accelerators, The Linac Components, The Head Assembly, The Gantry, Ancillary Equipment, The Linac Control Systems. The Treatment Planning Process, Patient Positioning and Acquisition of Anatomical Data, Alignment and Quality Control of Multi leaf Collimators, Flatness and Symmetry of Photon Beams, Energy Checks, Quality Control of Electron Beams, The Measurement of Percentage Depth Dose, Output Measurement, Checks on Dosimeters, Phantoms and Phantom Materials, Portal Imaging Devices.

Simulator: Introduction of Simulator, Description of the Standard Simulator, Special Features, Portal Imaging Devices: Introduction of Portal Imaging Devices, Film-Based Methods, Electronic Portal Imaging Devices.

Brachytherapy Equipment: Reconstruction procedure, Consistency between quantities and units, Decay corrections, Computer versus manual dose calculation for a single source, Source positioning with after loading devices Sources and applicators, Wipe tests, Autoradiography and uniformity checks of activity, Radiation monitoring around patients, Calibration. Introduction of Afterloading Equipment for Brachytherapy, Manual Afterloading, Remote-Controlled Afterloading: Low and Medium Dose Rates, Remote-Controlled Afterloading: High Dose Rates, Aspects of Quality Assurance for Afterloading Systems.

Quality System: Definitions, Requirements of a Quality System, Quality-Control Proce, Basis for Tolerance Limits, Accuracy Currently Achievable, ICRU Dose Specification and Reporting, Errors and Accidents, Equipment Quality Assurance.

BME 437 Nuclear Medicine

Credit 3.0 Contact Hours 3

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.