Curriculum Under Autonomy

With effective from Academic Year 2023-2024

(R23)

Curriculum Structure
B.Tech in Biomedical Engineering

1st Year 1st Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME101	Introduction to Cell Biology and Organ Systems	3	0	0	3	3
2	SCI	Multidisciplinary Course	M(BME)101	Engineering Mathematics - I	3	0	0	3	3
3	SCI	Multidisciplinary Course	CH(BME)101	Engineering Chemistry	2	0	0	2	2
4	HUM	Ability Enhancement Course	HU101	Professional Communication	2	0	0	2	2
5	HUM	Value Added Course	HU102	Values and Ethics	2	0	0	2	2
6	HUM	Value Added Course	HU103	Constitution of India	1	0	0	1	1
B. Practical									
7	ENGG.	Major	BME191	Introduction to Cell Biology and Organ Systems Lab	0	0	3	3	1.5
8	SCI	Skill Enhancement Course	CH(BME)191	Engineering Chemistry Lab	0	0	2	2	1
9	HUM	Ability Enhancement Course	HU191	Professional Communication Lab	0	0	2	2	1
10	ENGG.	Skill Enhancement Course	ME(BME)191	Workshop and Manufacturing Practices Lab	0	0	3	3	1.5
Total of Theory and Practical Courses								23	18

1st Year 2nd Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME201	Bioelectronics	3	0	0	3	3
2	ENGG	Minor	CS(BME)201	Programming for Problem Solving	3	0	0	3	3
3	SCI	Multidisciplinary Course	PH(BME)201	Engineering Physics	3	0	0	3	3
4	SCI	Multidisciplinary Course	M(BME)201	Engineering Mathematics - II	3	0	0	3	3
5	HUM	Value Added Course	HU204	Environmental Science	2	0	0	2	2
6	HUM	Value Added Course	HU205	Indian Knowledge System	1	0	0	1	1
B. Practical									
7	ENGG.	Major	BME291	Bioelectronics Lab	0	0	3	3	1.5
8	ENGG.	Minor	CS(BME)291	Programming for Problem Solving Lab	0	0	3	3	1.5
9	SCI	Skill Enhancement Course	PH(BME)291	Engineering Physics Lab	0	0	3	3	1.5
10	ENGG.	Skill Enhancement Course	ME(BME)291	Engineering Graphics and Design Lab	0	0	3	3	1.5
11	HUM	Ability Enhancement Course	HU(BME)291	Skill Development – I: Competencies in Social Skills	0	0	2	2	1
Total of Theory and Practical Courses								**29**	**22**

2nd Year 3rd Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME301	Human Anatomy and Physiology	3	0	0	3	3
2	ENGG.	Major	BME302	Biomechanics - I	3	0	0	3	3
3	ENGG.	Minor	EE(BME)301	Circuit Theory and Networks	3	0	0	3	3
4	ENGG.	Minor	M(BME)301	Numerical Methods and Statistics	3	0	0	3	3
5	ENGG.	Minor	EC(BME)301	Analog Electronics	3	0	0	3	3
B. Practical									
6	ENGG.	Major	BME391	Human Anatomy and Physiology Lab	0	0	3	3	1.5
7	ENGG.	Skill Enhancement Course	EE(BME)391	Circuit Theory and Networks Lab	0	0	2	2	1
8	ENGG.	Minor	M(BME)391	Numerical Methods and Statistics Lab	0	0	2	2	1
9	ENGG	Skill Enhancement Course	EC(BME)391	Analog Electronics Lab	0	0	3	3	1.5
10	HUM	Ability Enhancement Course	HU391	Skill Development – II: Technical seminar Presentation	0	0	2	2	1
Total of Theory and Practical Courses								**27**	**21**

2nd Year 4th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME401	Biomaterials	3	0	0	3	3
2	ENGG	Major	BME402	Biomechanics - II	3	0	0	3	3
3	ENGG	Major	BME403	Biophysical Signals and Systems	3	0	0	3	3
4	ENGG.	Minor	PH(BME)401	Medical Physics	2	0	0	2	2
5	ENGG	Minor	EC(BME)402	Digital Electronics and Devices	3	0	0	3	3
B. Practical									
6	ENGG.	Major	BME491	Biomaterials Lab	0	0	3	3	1.5
7	ENGG.	Major	BME492	Biomechanics Lab	0	0	3	3	1.5
8	ENGG.	Major	BME493	Biophysical Signals and Systems Lab	0	0	2	2	1
9	ENGG	Skill Enhancement Course	EC(BME)492	Digital Electronics and Devices Lab	0	0	2	2	1
10	HUM	Ability Enhancement Course	HU491	Skill Development – III: Analytical and Logical Thinking Skills - I	0	0	2	2	1
Total of Theory and Practical Courses								**26**	**20**

3rd Year 5th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	BME501	Biomedical Instrumentation	3	0	0	3	3
2	ENGG	Major	BME502	Biosensors and Transducers	3	0	0	3	3
3	ENGG	Major	BME503	Medical Imaging Systems - I	3	0	0	3	3
4	ENGG	Major	BME504A	Communication Systems and Biotelemetry	3	0	0	3	3
			BME504B	Bioelectrical and Bioelectronics Measurement					
			BME504C	Biomedical Informatics					
5	ENGG	Minor	CS(BME)505A	Data Structure and Algorithm	3	0	0	3	3
			EC(BME)505B	VLSI and Embedded System					
			EE(BME)505C	Measurement and Control System					
B. Practical									
6	ENGG.	Major	BME591	Biomedical Instrumentation Lab	0	0	2	2	1
7	ENGG.	Major	BME592	Biosensors and Transducers Lab	0	0	2	2	1
8	ENGG	Minor	CS(BME)595A	Data Structure and Algorithm Lab	0	0	2	2	1
			EC(BME)595B	VLSI and Embedded System Lab					
			EE(BME)595C	Measurement and Control System Lab					
9	HUM	Ability Enhancement Course	HU591	Skill Development - IV: Analytical and Logical Thinking Skills - II	0	0	2	2	1
10	PRJ	Project	BME581	Minor Project - I	0	0	2	2	1
Total of Theory and Practical Courses								**25**	**20**

3rd Year 6th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	BME601	Analytical and Diagnostic Equipment	3	0	0	3	3
2	ENGG	Major	BME602	Biosignal Processing	3	0	0	3	3
3	ENGG	Major	BME603	Medical Imaging Systems - II	3	0	0	3	3
4	ENGG	Major	BME604A	Biophysics and Biochemistry	3	0	0	3	3
			BME604B	Nanobiotechnology					
			BME604C	Tissue Engineering					
5	ENGG	Minor	CS(BME)605A	Database Management System	3	0	0	3	3
			EC(BME)605B	Microprocessor and Microcontroller					
			CS(BME)605C	Soft Computing					
B. Practical									
6	ENGG	Major	BME691	Analytical and Diagnostic Equipment Lab	0	0	2	2	1
7	ENGG	Major	BME692	Biosignal Processing Lab	0	0	2	2	1
8	ENGG	Minor	CS(BME)695A	Database Management System Lab	0	0	2	2	1
			EC(BME)695B	Microprocessor and Microcontroller Lab					
			CS(BME)695C	Soft Computing Lab					
9	PRJ	Project	BME681	Minor Project - II	0	0	4	4	2
10	PRJ	Internship	BME682	Internship	0	0	0	0	1
Total of Theory and Practical Courses								**25**	**21**

4th Year 7th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME701	Therapeutic Equipment	3	0	0	3	3
2	ENGG	Major	BME702	Medical Image Processing	3	0	0	3	3
3	ENGG	Major	BME703A	Hospital Engineering and Management	3	0	0	3	3
			BME703B	BioMEMs and Biomicrofluidics					
			BME703C	Drug Delivery System					
4	ENGG	Minor	EC(BME)704A	Laser and Optics in Healthcare	3	0	0	3	3
			EC(BME)704B	Medical Robotics and Automation					
			CS(BME)704C	Neural Network and Genetic Algorithm					
5	ENGG	Minor	CS(BME)705A	IOT and Telehealth Technology	3	0	0	3	3
			CS(BME)705B	Deep Learning and Machine Learning in Health Care					
			CS(BME)705C	Artificial Intelligence in Clinical Science					
B. Practical									
6	ENGG	Major	BME791	Therapeutic Equipment Lab	0	0	2	2	1
7	ENGG	Major	BME792	Medical Image Processing Lab	0	0	2	2	1
8	PRJ	Project	BME781	Major Project - I	0	0	6	6	3
9	PRJ	Internship	BME782	Industrial Training/ Internship	0	0	0	0	1
Total of Theory and Practical Courses								**25**	**21**

4th Year 8th Semester									
Sl No.	Broad Category	category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. Theory									
1	ENGG	Major	BME801	Artificial Organs and Rehabilitation Engineering	3	0	0	3	3
2	ENGG	Major	BME802	Modelling of Physiological System	3	0	0	3	3
3	ENGG	Major	BME803A	Biomedical Hazards and Safety	3	0	0	3	3
			BME803B	Radiotherapy and Nuclear Medicine					
			BME803C	Troubleshooting and Maintenance of Medical Equipment					
4	ENGG	Major	BME804A	Biological Control System	3	0	0	3	3
			BME804B	Computational Biology					
			BME804C	Quality Assurance and Regulatory Aspects of Medical Equipment					
B. Practical									
5	PRJ	Project	BME881	Major Project - II	0	0	12	12	6
6	ENGG	Major	BME882	Grand Viva	0	0	0	0	1
Total of Theory and Practical Courses								**24**	**19**

Total Credit: 162

Credit Distribution

Category	1st Semester	2nd Semester	3rd Semester	4th Semester	5th Semester	6th Semester	Total Credit toobtain UG Degree (Category Wise)	Credit Allocation as per NEP to obtain UG Degree	7th Semester	8th Semester	Total Credit (Category Wise)	Credit Allocation as per NEP
Major Course	4.5	4.5	7.5	13	14	14	**57.5**	**60**	11	13	**81.5**	**80**
Minor Course	-	4.5	10	5	4	4	**27.5**	**24**	6	-	**33.5**	**32**
Multidisciplinary Course	5	6	-	-	-	-	**11**	**9**	-	-	**11**	**9**
Ability Enhancement Courses (AEC)	3	1	1	1	1	-	**7**	**8**	-	-	**7**	**8**
Skill Enhancement Courses (SEC)	2.5	3	2.5	1	-	-	**9**	**9**	-	-	**9**	**9**
Value Added Courses common for all UG	3	3	-	-	-	-	**6**	**6 to 8**	-	-	**6**	**6 to 8**
Internship	-	-	-	-	-	1	**1**	**2 to 4**	1	-	**2**	**2 to 4**
Project	-	-	-	-	1	2	**3**	**-**	3	6	**12**	**12**
Total Credit (Semester Wise)	**18**	**22**	**21**	**20**	**20**	**21**	**122**	**120**	**21**	**19**	**162**	**160**

Distribution of Courses under Different Categories

Major Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Introduction to Cell Biology and Organ Systems	BME101	1ST	3:0:0	3
2	Introduction to Cell Biology and Organ Systems Lab	BME191	1ST	0:0:3	1.5
3	Bioelectronics	BME201	2ND	3:0:0	3
4	Bioelectronics Lab	BME291	2ND	0:0:3	1.5
5	Human Anatomy and Physiology	BME301	3RD	3:0:0	3
6	Human Anatomy and Physiology Lab	BME391	3RD	0:0:3	1.5
7	Biomechanics - I	BME302	3RD	3:0:0	3
8	Biomaterials	BME401	4TH	3:0:0	3
9	Biomaterials Lab	BME491	4TH	0:0:3	1.5
10	Biomechanics - II	BME402	4TH	3:0:0	3
11	Biomechanics Lab	BME492	4TH	0:0:3	1.5
12	Biophysical Signals and Systems	BME403	4TH	3:0:0	3
13	Biophysical Signals and Systems Lab	BME493	4TH	0:0:2	1
14	Biomedical Instrumentation	BME501	5TH	3:0:0	3
15	Biomedical Instrumentation Lab	BME591	5TH	0:0:2	1
16	Biosensors and Transducers	BME502	5TH	3:0:0	3
17	Biosensors and Transducers Lab	BME592	5TH	0:0:2	1
18	Medical Imaging Systems - I	BME503	5TH	3:0:0	3
19	Communication Systems and Biotelemetry	BME504A	5TH	3:0:0	3
	Bioelectrical and Bioelectronics Measurement	BME504B			
	Biomedical Informatics	BME504C			
20	Analytical and Diagnostic Equipment	BME601	6TH	3:0:0	3
21	Analytical and Diagnostic Equipment Lab	BME691	6TH	0:0:2	1
22	Biosignal Processing	BME602	6TH	3:0:0	3
23	Biosignal Processing Lab	BME692	6TH	0:0:2	1
24	Medical Imaging Systems - II	BME603	6TH	3:0:0	3
25	Biophysics and Biochemistry	BME604A	6TH	3:0:0	3
	Nanobiotechnology	BME604B			
	Tissue Engineering	BME604C			
Total credit for Major Courses Upto 3rd Year					**57.5**
26	Therapeutic Equipment	BME701	7TH	3:0:0	3
27	Therapeutic Equipment Lab	BME791	7TH	0:0:2	1
28	Medical Image Processing	BME702	7TH	3:0:0	3
29	Medical Image Processing Lab	BME792	7TH	0:0:2	1
30	Hospital Engineering and Management	BME703A	7TH	3:0:0	3
	BioMEMs and Biomicrofluidics	BME703B			

	Drug Delivery System	BME703C			
31	Artificial Organs and Rehabilitation Engineering	BME801	8TH	3:0:0	3
32	Modelling of Physiological System	BME802	8TH	3:0:0	3
33	Biomedical Hazards and Safety	BME803A	8TH	3:0:0	3
	Radiotherapy and Nuclear Medicine	BME803B			
	Troubleshooting and Maintenance of Medical Equipment	BME803C			
34	Biological Control System	BME804A	8TH	3:0:0	3
	Computational Biology	BME804B			
	Quality Assurance and Regulatory Aspects of Medical Equipment	BME804C			
35	Grand Viva	BME882	8TH	0:0:0	1
Total credit for Major Courses Upto 4th Year					**81.5**

Minor Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Programming for Problem Solving	CS(BME)201	2ND	3:0:0	3
2	Programming for Problem Solving Lab	CS(BME)291	2ND	0:0:3	1.5
3	Circuit Theory and Networks	EE(BME)301	3RD	3:0:0	3
4	Numerical Methods and Statistics	M(BME)301	3RD	3:0:0	3
5	Numerical Methods and Statistics Lab	M(BME)301	3RD	0:0:2	1
6	Analog Electronics	EC(BME)301	3RD	3:0:0	3
7	Medical Physics	PH(BME)401	4TH	2:0:0	2
8	Digital Electronics and Devices	EC(BME)402	4TH	3:0:0	3
9	Data Structure and Algorithm	CS(BME)505A	5TH	3:0:0	3
	VLSI and Embedded System	EC(BME)505B			
	Measurement and Control System	EE(BME)505C			
10	Data Structure and Algorithm Lab	CS(BME)595A	5TH	0:0:2	1
	VLSI and Embedded System Lab	EC(BME)595B			
	Measurement and Control System Lab	EE(BME)595C			
11	Database Management System	CS(BME)605A	6TH	3:0:0	3
	Microprocessor and Microcontroller	EC(BME)605B			
	Soft Computing	CS(BME)605C			
12	Database Management System Lab	CS(BME)695A	6TH	0:0:2	1
	Microprocessor and Microcontroller Lab	EC(BME)695B			
	Soft Computing Lab	CS(BME)695C			
Total Credit for Minor Courses Upto 3rd Year					**27.5**
13	Laser and Optics in Healthcare	EC(BME)704A	7TH	3:0:0	3
	Medical Robotics and Automation	EC(BME)704B			
	Neural Network and Genetic Algorithm	CS(BME)704C			

14	IOT and Telehealth Technology	CS(BME)705A	7TH	3:0:0	3
	Deep Learning and Machine Learning in Health Care	CS(BME)705B			
	Artificial Intelligence in Clinical Science	CS(BME)705C			
Total Credit for Minor Courses Upto 4th Year					**33.5**

Multidisciplinary Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Engineering Mathematics - I	M(BME)101	1ST	3:0:0	3
2	Engineering Chemistry	CH(BME)101	1ST	2:0:0	2
3	Engineering Physics	PH(BME)201	2ND	3:0:0	3
4	Engineering Mathematics - II	M(BME)201	2ND	3:0:0	3
Total Credit for Multidisciplinary Courses Upto 3rd Year/4th Year					**11**

Ability Enhancement Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Professional Communication	HU101	1ST	2:0:0	2
2	Professional Communication Lab	HU191	1ST	0:0:2	1
3	Skill Development – I: Competencies in Social Skills	HU(BME)291	2ND	0:0:2	1
4	Skill Development – II: Technical seminar Presentation	HU391	3RD	0:0:2	1
5	Skill Development – III: Analytical and Logical Thinking Skills - I	HU491	4TH	0:0:2	1
6	Skill Development - IV: Analytical and Logical Thinking Skills - II	HU591	5TH	0:0:2	1
Total Credit for Ability Enhancement Courses Upto 3rd Year/4th Year					**7**

Skill Enhancement Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Engineering Chemistry Lab	CH(BME)191	1ST	0:0:2	1
2	Workshop and Manufacturing Practices Lab	ME(BME)191	1ST	0:0:3	1.5
3	Engineering Physics Lab	PH(BME)291	2ND	0:0:3	1.5
4	Engineering Graphics and Design Lab	ME(BME)291	2ND	0:0:3	1.5
5	Circuit Theory and Networks Lab	EE(BME)391	3RD	0:0:2	1
6	Analog Electronics Lab	EC(BME)391	3RD	0:0:3	1.5
7	Analog Electronics Lab	EC(BME)492	4TH	0:0:2	1
Total Credit for Skill Enhancement Courses Upto 3rd Year/4th Year					**9**

Value Added Courses

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Values and Ethics	HU102	1ST	2:0:0	2
2	Constitution of India	HU103	1ST	1:0:0	1
3	Environmental Science	HU204	2ND	2:0:0	2
4	Indian Knowledge System	HU205	2ND	1:0:0	1
Total Credit for Value Added Courses Upto 3rd Year/4th Year					**6**

Internship

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Internship	BME682	6TH	0:0:0	1
2	Industrial Training/ Internship	BME782	7TH	0:0:0	1
Total Credit for Internship Upto 3rd Year/4th Year					**2**

Project

Sl. No.	Name of the Course	Course Code	Semester	L:T:P	Credit
1	Minor Project - I	BME581	5TH	0:0:2	1
2	Minor Project - II	BME681	6TH	0:0:4	2
3	Major Project - I	BME781	7TH	0:0:6	3
4	Major Project - II	BME881	8TH	0:0:12	6
Total Credit for Project Upto 3rd Year/4th Year					**12**

Mandatory Additional Requirements (MAR)
as per MAKAUT
Dated: 04.12.2023

Mandatory Additional Requirements (MAR) Activity List w.e.f. 2023-2024

Activity		Points per Activity	Permissible Points (max)
1. ***MOOCS (SWAYAM/NPTEL/Spoken Tutorial/any technical, non-technical course) (per course)***			
a)	**For 12 weeks duration/40 Hours**	20	40
b)	**For 8 weeks duration/30 Hours**	15	
c)	**For 4 weeks duration/20 Hours**	10	
d)	**For 2 weeks duration/10 Hours**	5	
2. Tech Fest/Fest/Teachers Day/Fresher's Welcome			
a)	Organizer	5	10
b)	Participant	3	6
3. Rural Reporting		5	10
4. Tree plantation and Up-keeping (per tree)		1	10
5. Relief/Charitable Activities			
a)	**Collection of fund/ materials for the Relief Camp or Charitable Trusts**	5	40
b)	**To be a part of the Relief Work Team**	20	
6. Participation in Debate/Group Discussion/Workshop/Tech quiz/Music/Dance/Drama/Elocution/Quiz/Seminar/Painting/ any Performing Arts/Photography/Film Making/		10	20
7. Publication in News Paper, Magazine, Wall Magazine & Blogs		10	20
8. Research Publication (per publication)		15	30
9. Innovative Projects (other than course curriculum)		30	60
10	**Blood donation**	8	16
	Blood Donation Camp Organization	10	20
11. Sports/Games/Adventure Sports/Trekking/Yoga Camp			
a)	**Personal Level**	10	20
b)	**College level**	5	10
c)	**University Level**	10	20
c)	**District Level**	12	24
e)	**State Level**	15	30
f)	**National/International Level**	20	20
12. Activities in a Professional Society/Student Chapter		10	20
13. Relevant Industry Visit & Report/Hotel-Event Management Training & Report (Minimum 3 days with submitted report)		10	20
14. Community Service & Allied Activities like: Caring for the Senior Citizens, Under-privileged/Street Children/ Animal Care etc/ Training to Differently Able		10	20
15. Self-Entrepreneurship Programme			
a)	**To organise entrepreneurship programmes and workshops**	10	20
b)	**To take part in entrepreneurship workshop and get certificate**	5	10
c)	**Video film making on entrepreneurship**	10	20
d)	**Submit business plan on any project**	10	20
e)	**To work for start-up/as entrepreneur**	20	40

Massive Open Online Courses (MOOCs) scheme at MAKAUT, WB (Applicable from the session 2020-21)

All India Council for Technical Education (AICTE) has introduced Model Curriculum for Bachelor of Technology programme with 160 credits in the entire programme of 4 years, and additional 20 credits will be required to be achieved through Massive Open Online Courses (MOOCs) from different platform for the degree of Bachelor of Technology with Honours. These additional 20 credits will have to be acquired with online courses (MOOCs) as per AICTE. Students of B Tech program will have to complete additional 20 credits through MOOCs within 4 years of time. 16 credit points is applicable for 3 year UG programs. This creates an excellent opportunity for students to acquire the necessary additional skill set for employability through massive open online courses where the rare expertise of world famous experts from academics and industry are available. Maulana Abul Kalam Azad University of Technology, West Bengal (MAKAUT, WB) has thus decided to introduce AICTE model curriculum for its B.Tech Programmes and allow students to choose courses from any established online platform as per following revised guidelines from academic year 2020-21.

GUIDELINES FOR MOOCs

MOOCs (Massive Open Online Courses) have been inducted in University curriculum and academic activities in the following ways:

1. MOOCs for Honours Degree at Undergraduate Level.
2. MOOCs for mandatory Coursework of Research Scholars for Ph.D. degree
3 MOOCs are also used for credit transfer as equivalent to theory courses of Curriculum under recommendation of BoS.
4. MOOCs for Mandatory Additional Requirements (MAR)

MOOCs for B.Tech Honours Degree

For B.Tech Honours Degree, a B.Tech student will have to earn 20 credits from MOOCs from any established MOOCs platform addition to 160 credits for B.Tech degree.

The total of 20 credits that is required to attain eligibility for B.Tech Honours degree is distributed over four years in the following way:

1st year: 4-8 credits **2ndyear: 4-8 credits**
3rdyear: 4-8 credits **4thyear: 4 credits**

A student of first year has to cover courses from at least three skills:

1. Computer Programing with Python /R
2. Softskill
3. Ethics

Students of all streams are to be equipped with Programming skill in the language that is in high demand worldwide in the first year itself so that they can apply this skill in thesubsequent semesters in their different areas including their core area of study.

Soft skill is very essential for grooming of the student and student must be exposed to it in the very beginning of the 4 years long program.

Ethics is something that one should practice. Students are to be made aware of the ethics right in the beginning of the 4 years long program so that they can practice at least some of the ethical norms as applicable to Institutional environment and society, and be prepared to practice ethics in their working life.

All of the MOOCs courses are to be taken any MOOCs platform as per following scheme of credit points. There would not be any concept of fixed basket anymore. However, during choosing courses in the online platform students would essentially avoid the courses taught/offered through the curriculum in the offline / class room mode.

MOOCs Curriculum for B. Tech BME Hons.

Sl No.	Course Name	Year	Duration	Credit
1	Biomechanics of Joints and Orthopaedic Implants	2ND	12W	3
2	Transport Phenomena in Biological Systems	2ND	12W	3
3	Mathematical Aspects of Biomedical Electronic System Design	2ND	12W	3
4	Fabrication Techniques for MEMs-based sensors : clinical perspective	2ND	12W	3
5	Physics of Biological Systems	2ND	12W	3
6	Biomechanics	2ND	12W	3
7	Medical Biomaterials	2ND	8W	2
8	Signals & Systems	2ND	12W	3
9	User-centric Computing for Human-Computer Interaction	2ND	8W	2
10	Biomedical Signal Processing	2ND	12W	3
11	BioMEMS and Microfluidics	3RD	8W	2
12	Drug Delivery: Principles and Engineering	3RD	12W	3
13	Electrocardiogram- Interpretation and application in clinical practice	3RD	4W	1
14	Design & Implementation of Human- Computer Interfaces	3RD	12W	3
15	Bioengineering: An Interface with Biology and Medicine	3RD	8W	2
16	Computational System Biology	3RD	12W	3
17	Bioinformatics: Algorithms and Applications	3RD	12W	3
18	Embedded System Design	3RD	12W	3
19	Medical Image Analysis	3RD	4W	1
20	Artificial Intelligence- Knowledge Representation & Reasoning	3RD	12W	3
21	Organ Printing	4TH	8W	2
22	Computer Aided Drug Design	4TH	8W	2
23	Medical Image Analysis	4TH	12W	3
24	Digital Image Processing	4TH	12W	3

1st Year 1stSemester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME101	Introduction to Cell Biology and Organ Systems	3	0	0	3	3
2	SCI	Multidisciplinary Course	M(BME)101	Engineering Mathematics - I	3	0	0	3	3
3	SCI	Multidisciplinary Course	CH(BME)101	Engineering Chemistry	2	0	0	2	2
4	HUM	Ability Enhancement Course	HU101	Professional Communication	2	0	0	2	2
5	HUM	Value Added Course	HU102	Values and Ethics	2	0	0	2	2
6	HUM	Value Added Course	HU103	Constitution of India	1	0	0	1	1
B. Practical									
7	ENGG.	Major	BME191	Introduction to Cell Biology and Organ Systems Lab	0	0	3	3	1.5
8	SCI	Skill Enhancement Course	CH(BME)191	Engineering Chemistry Lab	0	0	2	2	1
9	HUM	Ability Enhancement Course	HU191	Professional Communication Lab	0	0	2	2	1
10	ENGG.	Skill Enhancement Course	ME(BME)191	Workshop and Manufacturing Practices Lab	0	0	3	3	1.5
Total of Theory and Practical Courses								23	18

A. Theory

COURSE NAME: INTRODUCTION TO CELL BIOLOGY AND ORGAN SYSTEMS
COURSE CODE: BME101
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic knowledge of Biology.

Course Outcomes:

After completion of this course students will be able to

CO1: Illustrate the evolutionary path in which the elements of an organism are delineated.

CO2: Correlate the structure-function architecture and relationship in dispersion through biomolecules, cells, tissues, organs, systems and organisms.

CO3: Identify problems related to structural deformity or functional deviation in chronological development of organisms from basic unit of life.

CO4: Analyse Inheritance and Variation related abnormality and its impact on health, safety, environment and society.

Course Content:

Module- 1: Basic Cell Biology **8L**

Cell: Definition, shape and size; Cell theory; Structure of a Cell: Cell Envelop, Cytoplasm, Nucleus, Cell Organelles; Plant Cell and Animal Cell; Prokaryotic and Eukaryotic Cell; Cells grow and reproduce; Cellular differentiation; Cell metabolism; Cells respond to their external environments.

Module- 2: Cell cycle &Cell Division **6L**

Phases of Cell Cycle; Interphase; M-Phase; Amitosis or Direct Cell Division; Mitosis and its significance; Meiosis and its significance.

Module- 3: Structural Organisation in Animals (Tissues to Organ System) **6L**

Animal Tissues: Epithelial, Connective, Muscular and Nervous Tissue. Structural Architecture: Tissues, Organ, System and Organism; Overview of various organ systems.

Module- 4: Biomolecules **8L**

Primary and Secondary Metabolites; Carbohydrates; Amino Acids; Proteins; Lipids; Nucleic Acids; Enzymes; Dynamic state of body Constituents-Concept of Metabolism.

Module- 5: Principles of Inheritance and Variation **8L**

Mandel's Laws of Inheritance: Inheritance of one gene; Inheritance of two genes; Sex determination; Mutation; Genetic Disorders: Pedigree Analysis; Mendelian Disorders; Chromosomal Disorders.

Text Books:

1. Biology: A global approach by N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, Pearson Education Ltd, 2018.
2. Cell and Molecular Biology-P.K.Gupta. Rastogi Publications 2009
3. Cell Biology (Cytology, Biomolecules and Molecular Biology) By Verma P.S. & Agarwal V.K. S. Chand Publishing, 2016
4. Molecular Biology of the Gene by Warson JD, Baker, TA, Bell SP, Gann A, Levin M, Losick R, Pearson Education, 2004.

Reference Books:

1. Molecular Genetics: An Introductory Narrative by Stent, Gunther S.; Calendar, Richard.W.H. Freeman & Co Ltd.
2. Biochemistry by Debajyoti Das. Academic Publishers.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
Avg.	**3**	**2.67**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: ENGINEERING MATHEMATICS - I
COURSE CODE: M(BME)101
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra, and calculus.

Course Outcomes:

After completion of this course students will be able to

CO1: Recall the properties related to matrix algebra and calculus.

CO2: Determine the solutions of the problems related to matrix algebra and calculus.

CO3: Apply the appropriate mathematical tools of matrix algebra and calculus for the solutions of the problems.

CO4: Analyze different engineering problems linked with matrix algebra and calculus.

Course Content:

Module-1: Liner Algebra **10L**

Echelon form and normal (canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigen values and eigenvectors; Cayley-Hamilton theorem.

Module-2: Single Variable Calculus **5L**

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Concept of sequence and series, Power series; Taylor's series.

Module-3: Multivariable Calculus (Differentiation) **14L**

Function of several variables; Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function; Jacobian; Maxima and minima of functions of two variables, Gradient, Directional derivatives, Divergence, Curl.

Module-4: Multivariable Calculus (Integration) **7L**

Double Integral, Triple Integral; Change of order in multiple integrals; Line Integral, Surface Integral, Volume Integral. Change of variables in multiple integrals.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
6. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
7. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
8. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
9. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
10. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Avg.	**2.75**	**2.25**	**1.5**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.25**

COURSE NAME: ENGINEERING CHEMISTRY
COURSE CODE: CH(BME)101
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisites: Knowledge of chemistry as per 12^{th} standard.

Course Outcomes:

After completion of this course students will be able to

CO1: Understand the basic principles of elements, organic reactions, drug synthesis and computational chemistry.

CO2: Apply the knowledge of different engineering materials, advanced polymers, and non-materials to solve complex engineering problems.

CO3: Analyse and evaluate water quality parameters and its treatment.

CO4: Gain the knowledge of free energy, energy storage device, fuels and corrosion to design environment friendly & sustainable devices.

CO5: Apply the knowledge of different instrumental techniques to analyse unknown engineering materials.

Course Content:

Module – 1: Elements and their properties 6L

1. Elements and their properties (3L)

Bohr's theory for one electron system, Hydrogen spectrum, Quantum numbers, Atomic orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle, Electronic configuration and Magnetic properties.

2. Periodic Table for Engineers (3L)

Modern Periodic table, Periodic properties, study of advanced functional materials like Silicones, Silicates, Zeolite and alloys like steel, mischmetall, Neodymium alloy and their applications

Module 2 - Energy devices and Semiconductors 6L

1. Use of free energy in chemical equilibria (3L)

Laws of Thermodynamics, Enthalpy, Entropy, Spontaneity, Electrochemical Cell, Dry Cell, Mercury Cell, Lead Storage batteries, Fuel Cells, Solar Cells, Nernst equation and applications, Electrochemical sensors

2. Crystals and Semiconductors (3L)

Crystals and their defects, Stoichiometric and Non-stoichiometric defects, Band theory and Doping, n-type and p-type semiconductors, Superconductors

Module 3 –Industrial Applications of Chemistry 8L

1. Advanced Polymeric materials (3L)

Classification, Engineering Plastics, conducting polymers, bio polymers, polymer composites.

2. Industrial corrosion (2L)

Classification, Effects of corrosion, Preventive measures

3. Analysis of Water Quality (1L)

Water quality parameters

4. Fuels and their applications (2L)

Classification of Fuels, Calorific Values, Solid fuels; coal qualifications, Liquid Fuels; Knocking, Cetane and Octane number, composition and uses of gaseous fuels; water gas, Bio Gas, CNG, LPG

Module 4 – Organic Reaction Products and their spectroscopic analysis 4L

1. Organic Reactions (2L)

Substitution, Elimination and Addition reactions

2. Drug designing and synthesis (1L)

Paracetamol, Aspirin

3. Spectroscopic Analysis (1L)

UV-Visible Spectra, IR spectra

Text Books:

1. Fundamentals of Engineering Chemistry, By Dr. Sudip Bandopadhyay & Dr. Nirmal Kumar Hazra
2. A Text Book of Engineering Chemistry by Dr. Rajshree Khare
3. Engineering Chemistry 1, Gourkrishna Dasmohapatra

Reference Books

1. Engineering Chemistry, 16th Edition, P.C. Jain & Dr. Monica Jain
2. A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co.
3. Fundamentals of Molecular Spectroscopy, by C. N.Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan

CO - PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**2**
CO3	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**2**
CO4	**3**	**3**	**3**	**2**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
Avg.	**3**	**3**	**2.75**	**2.5**	**2**	**-**	**2.67**	**-**	**-**	**-**	**2.4**	**2**

COURSE NAME: PROFESSIONAL COMMUNICATION
COURSE CODE: HU101
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisite: Knowledge of 12th Standard English grammar, vocabulary, reading and writing skills.

Course Outcomes:

After completion of this course students will be able to

CO1: Define, describe and classify the modalities and nuances of communication in a work-place context.

CO2: Review, appraise and understand the modes, contexts and appropriacy of communicating across cultures and societies.

CO3: Identify, interpret and demonstrate the basic formats, templates of business and official communication.

CO4: Identify, compare and illustrate reading strategies and basic writing strategies.

CO5: Interpret, analyze and evaluate semantic-structural, interpersonal and multicultural dynamics in business communication.

Course Content:

Module - 1: Verbal and Non Verbal Communication 4L

Definition, Relevance and Effective usage, Components of Verbal Communication: Written and Oral Communication, Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics Para-language, Barriers to Effective Communication.

Module - 2: Workplace Communication Essentials and Cross Cultural Communication 4L

Communication at the Workplace: Formal and Informal Situations, Language in Use - Jargon, Speech Acts/Language Functions, Syntactical and Grammatical Appropriacy, Cultural Contexts in Global Business: High Context and Low Context Cultures, Understanding Cultural Nuances and Stereotyping, Achieving Culturally Neutral Communication in Speech and Writing.

Module - 3: Reading Strategies and Basic Writing Skills 4L

Reading: Purposes and Nature of Reading, Reading Sub-Skills—Skimming, Scanning, Intensive Reading, Reading General and Business Texts (Reading for Comprehension and Detailed Understanding), Basic Writing Skills - Paragraph and Essay writing, writing technical documents; Writing Technicalities - Paragraphing, Sentence Structure and Punctuation.

Module - 4: Report Writing 4L

Nature and Function of Reports, Types of Reports, Researching for a Business Report, Format, Language and Style, Report Documentation

Module - 5: Employment Communication 8L

a. Writing Business Letters - (Enquiry, Order, Sales, Complaint, Adjustment, Job Application, Offer) **2L**

b. Creating an Employee Profile, Preparing a CV or Résumé. Creating a Digital/ Online

Profile–LinkedIn (Résumé/Video Profile) **2L**

c. Writing Other Inter office Correspondence--E-mails: types, convention, and etiquette, Memo, Notices and Circulars **2L**

d. Preparing Meeting Documentation—Drafting Notice and Agenda of Meetings, Preparing Minutes of Meetings. **2L**

Text/ Reference Books:

1. Meenakshi Raman and Sangeetha Sharma. *Technical Communication*. 3rd edition. New Delhi: Oxford University Press, 2015.
2. Mark Ibbotson. *Cambridge English for Engineering*. Cambridge: Cambridge University Press, 2008.
3. Mark Ibbotson. *Professional English in Use: Engineering*. Cambridge: Cambridge UP,2009.
4. Lesikaretal. *Business Communication: Connecting in a Digital World*. New Delhi: Tata McGraw-Hill, 2014.
5. John Seeley. *Writing Reports*. Oxford: Oxford University Press, 2002.
6. Judith Leigh. *CVs and Job Applications*. Oxford: Oxford University Press, 2002.
7. Judith Leigh. *Organizing and Participating in Meetings*. Oxford: Oxford University Press, 2002.
8. Michael Swan. *Practical English Usage*. Oxford: OUP, 1980.
9. Pickett, Laster and Staples. *Technical English: Writing, Reading & Speaking.* 8th ed. London: Longman,2001.
10. Diana Booher. *E-writing: 21stCentury Tools for Effective Communication*.

Links:-

1. Purdue University's Online Writing Lab (OWL)- https://owl.purdue.edu/
2. Business English Pod- https://www.businessenglishpod.com/

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	1	1	2	3	-	2
CO2	-	-	-	-	-	1	1	2	2	3	-	3
CO3	-	-	-	-	-	3	3	1	1	3	2	3
CO4	-	-	-	-	-	3	3	1	-	3	-	3
CO5	-	-	-	-	-	2	2	2	2	3	-	3
Avg.	-	-	-	-	-	2	2	1.4	1.75	3	2	2.8

COURSE NAME: VALUES AND ETHICS
COURSE CODE: HU102
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisite: None

Course Outcomes:

After completion of this course students will be able to

CO1: Understand the core values that shape the ethical behaviour of an engineer and Exposed awareness on professional ethics and human values.

CO2: Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories.

CO3: Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field.

CO4: Aware of responsibilities of an engineer for safety and risk benefit analysis, professional rights and responsibilities of an engineer.

CO5: Acquire knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.

Course Content:

Module 1: Value **4L**

Definition, Importance and application of Value in life, Formation of Value, Process of Socialization, Self and integrated personality, Types of Values – Social, Psychological, Aesthetic, Spiritual and Organizational, Value crisis in contemporary society: individual, societal, cultural and management level.

Module-2: Effects of Technological Growth **4L**

Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Problems of Technology transfer- Technology assessment impact analysis. Human Operator in Engineering projects and industries- Problems of man, machine- interaction- Impact of assembly line and automation-Human centred Technology.

Module-3: Impact of Ethics on Business Policies and Strategies **4L**

Utilitarianism, Principles of Utilitarianism, Criticism of Utilitarianism, Impact on Business Culture, Role of CEO in shaping Business Culture, Ethical Leadership, Characteristics.

Module-4: Types of Ethical issues **2L**

Internal Ethics of Business, Hiring Employees, Promotion, Wages, Job discrimination - its nature and extent, Exploitation of Employees, Discipline and Whistle Blowing.

Module-5: Markets and consumer Protection **4L**

Consumer rights, Unethical Practices in Marketing, Ethics of Competition and Fair Prices, Ethics in Advertising and False Claims, Environmental Protection and Ethics, Pollution Control, Ecological ethics.

Module-6: Social Responsibilities of Business **6L**

Definition and case study of Corporate Compliance; Responsibilities towards Customers, shareholders, employees, Social Audit: Objectives and Need for Social Audit, Methods of Social Audit, Benefits, Obstacles, Social Audit in India.

Text Books:

1. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996
2. S. K. Chakraborty: Values and Ethics in Organization, OUP

Reference Books:

1. U.C.Mathur, Corporate Governance & Business Ethics, Macmillan, 2005
2. Fernando. A. C., Business Ethics – An Indian Perspective, Pearson Publication, 2009.
3. Prem Vir Kapoor, Professional Ethics & Human Values, Khanna Publishing House, New Delhi

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	-	3	-	1	2	1
CO2	-	2	-	-	-	1	-	2	3	3	3	2
CO3	-	-	-	-	-	3	3	2	3	1	3	2
CO4	-	2	-	-	-	3	3	-	3	-	3	2
CO5	-	-	-	-	-	3	-	-	-	-	2	-
Avg.	-	2	-	-	-	2.4	3	2.33	3	1.67	2.6	1.75

COURSE NAME: CONSTITUTION OF INDIA
COURSE CODE: HU103
CONTACT: 1:0:0
TOTAL CONTACT HOURS: 12
CREDIT: 1

Prerequisite: None

Course Outcomes:

After completion of this course students will be able to

CO1: Identify and explore the basic features and modalities of Indian constitution.

CO2: Differentiate and relate the functioning of Indian parliamentary system at the centre and state level.

CO3: Differentiate the various aspects of Indian Legal System and its related bodies.

Course Content:

Module - 1: **History of Making of the Indian Constitution: 3L**

History, Drafting Committee, (Composition & Working), Philosophy of the Indian Constitution: Preamble Salient Features**.**

Module - 2: Fundamental Rights, Fundamental Duties, Directive, Principles of State Policy: 6L

The Right to Equality

The Right to Freedom: I (Article 19)

The Right to Freedom: II (Articles 20, 21 and 22)

The Right against Exploitation

The Right to freedom of Religion

Cultural and Educational rights

The Right to Property

The Right to Constitutional Remedies

Fundamental Duties

Module - 3: Organs of Governance 3L

Parliament - Composition - Qualifications and Disqualifications -Powers and Functions – Executive- President -Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

Text Book:

1) Indian Constitution by D.D.Basu, The Publisher, LexisNexis
2) PM Bhakshi, The constitution of India, Universal Law, 14e, 2017

Reference Books:

1) Constitution of India by Subhas C Kasyap, Vitasta Publishing

2) The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
3) Indian Constitution Text Book - Avasthi, Avasthi,Publisher: LAKSHMI NARAIN AGARWAL
4) Introduction to the Constitution of India, Brij Kishore Sharma, PHI

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	**2**	-	**3**	-	**1**	-	-
CO2	-	-	-	-	-	**1**	-	**2**	-	**3**	-	-
CO3	-	-	-	-	-	**3**	-	**2**	-	**1**	-	-
Avg.	-	-	-	-	-	**2**	-	**2.33**	-	**1.67**	-	-

B. Practical

COURSE NAME: INTRODUCTION TO CELL BIOLOGY AND ORGAN SYSTEMS LAB
COURSE CODE: BME191
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of Biology

Course Outcomes:

After completion of this course students will be able to

CO1: Integrate the gross structural orientation of various cells and tissues through microscopic approach.

CO2: Perform histological experiments using necessary lab tools to get hands-on exposure of the structure function relationship of tissues.

CO3: Identify various phases of Mitosis and Meiosis using permanent slides

CO4: Execute experiments as an individual as well as a member in a team, maintaining ethics and norms of Cell Biology laboratory practice.

List of Experiments:

1. Study on Compound Microscope.
2. Identification of permanent slides: Prokaryotic Cell, Eukaryotic cell, Plant Cell, Animal Cell.
3. Study of structural and functional variation of cell using fixed histological slides: Stem cells, Bone cells, Cartilage cells, Blood cells, Nerve cells, Fat cells.
4. Preparation of temporary mounts of human cheek squamous epithelial cells to observe under microscope.
5. Preparation of temporary mounts of Striated muscle fibers to observe under microscope.
6. Blood film making and identification of different blood corpuscles.
7. Study of the phases of mitosis using permanent slides.
8. Study of the phases of meiosis using permanent slides.
9. Innovative experiment

Text Books/ Reference Books:

1. Essentials of Human Anatomy and amp; Physiology Laboratory Manual, 7th edition. Elaine N Marieb; Pamela B. Jackson. Pearson Publication

2. diFiore's Atlas of Histology with Functional Correlations, 12th International Edition. Victor P. Eroschenko. Publisher-Lippincott Williams and Wilkins.

CO - PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	2	-	-	-	-	-	-	-
CO2	3	2	-	-	2	3	-	-	-	-	-	2
CO3	3	2	-	-	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	3	3	-	-	2
Avg.	3	2	-	-	2	3	-	3	3	-	-	2

COURSE NAME: ENGINEERING CHEMISTRY LAB
PAPER CODE: CH(BME)191
CONTACT: 0:0:2
CREDIT: 1
Prerequisites: Knowledge of 12^{th} standard chemistry.

Course Outcomes:

After completion of this course students will be able to

CO1: Operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.

CO2: Analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member.

CO3: Analyse different parameters of water considering environmental issues.

CO4: Synthesize drug and sustainable polymer materials.

CO5: Design innovative experiments applying the fundamentals of modern chemistry.

List of Experiments:

1. Determination of the concentration of the electrolyte through conductance measurement.
2. Determination of water quality measurement techniques.
3. Determination of the concentration of the electrolyte through pH measurement.
4. Estimation of Cu in brass
5. Estimation of Fe_2O_3 in Cement
6. Isolation of graphene from dead dry batteries and their use for temporary soldering.
7. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
8. Estimation of corrosion in a given sample metal.
9. Preparation of Si-nano crystals for future memory devices.
10. Green Synthesis of ZnO based Polymer Nano composites.
11. Synthesis of polymers for electrical devices and PCBs.
12. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
13. Drug design and synthesis
14. Rheological properties of the Newtonian fluids
15. Innovative Experiments

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1	-	2	3	-	-	-	-	1
CO2	2	2	1	1	-	1	-	-	-	1	-	1
CO3	-	-	-	-	-	-	-	-	3	3	2	2
CO4	2	1	2	2	-	-	1	-	-	-	-	2
CO5	3	3	3	3	1	1	1	1	-	-	2	2
Avg.	2.5	1.75	2.25	1.75	1	1.33	1.67	1	3	2	2	1.6

COURSE NAME: PROFESSIONAL COMMUNICATION LAB
COURSE CODE: HU191
CONTACT: 0:0:2
CREDIT: 1

Pre requisites: Basic knowledge of LSRW skills.

Course Outcomes:

After completion of this course students will be able to

CO1: Recognize, identify and express advanced skills of Technical Communication in English through Language Laboratory.

CO2: Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.

CO3: Articulate and present the skills necessary to be a competent Interpersonal communicator.

CO4: Deconstruct, appraise and critique communication behaviours.

CO5: Adapt, negotiate and facilitate with multifarious socio-economical and professional arenas with effective communication and interpersonal skills.

Course Contents:

Module 1: Introduction to the Language Lab
a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book

Module 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Listening in Business Telephony

Module 3: Speaking
a. Speaking - Accuracy and Fluency Parameters
b. Pronunciation Guide - Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities - JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities - Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
f. Giving a Presentation - Learning Presentation Basics and Giving Micro Presentations

Module 4: Lab Project Work
a. Writing a Book Review
b. Writing a Film Review
c. Scripting a Short Presentation (2 minutes)
d. Making a short video CV (1-2 minutes)

Text/ References:

1. IIT Mumbai**,** *Preparatory Course in English syllabus*.
2. IIT Mumbai, *Introduction to Linguistics syllabus*

3. Sasikumar et al. *A Course in Listening and Speaking*. New Delhi: Foundation Books, 2005.
4. Tony Lynch, *Study Listening*. Cambridge: Cambridge UP, 2004.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**-**	**-**	**2**	**-**	**-**	**1**	**1**	**-**	**2**	**3**	**-**	**2**
CO2	**-**	**-**	**2**	**2**	**-**	**3**	**3**	**-**	**2**	**3**	**-**	**3**
CO3	**-**	**-**	**2**	**2**	**-**	**3**	**3**	**2**	**2**	**3**	**-**	**3**
CO4	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**2**	**3**	**-**	**3**
CO5	**-**	**-**	**2**	**2**	**-**	**3**	**3**	**2**	**2**	**3**	**-**	**3**
Avg.	**-**	**-**	**2**	**2**	**-**	**1.6**	**2.6**	**2**	**2**	**3**	**-**	**2.8**

COURSENAME: WORKSHOP AND MANUFACTURING PRACTICES LAB
COURSECODE: ME(BME)191
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Knowledge of 12th standard Physics & Mathematics

Course Outcomes:

After completion of this course students will be able to

CO1: Gain basic knowledge of Workshop Practice and Safety useful for our daily living.

CO2: Understand the use of Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc.

CO3: Apply and performing operations like such as Marking, Cutting etc. used in manufacturing processes.

CO4: Analyse the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc to understand the concept of tolerances applicable in all kind of manufacturing.

CO5: Get hands on practice of in Welding and apply various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

Course Content:

(i)Theoretical discussions:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing, 3D Printing
8. Plastic moulding & Glass Cutting

(ii)Workshop practice:

At least 6 modules should be covered

Module - 1: Machine shop

Typical jobs that may be made in this practice module:

i. To make a pin from a mild steel rod in a lathe.

ii. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and/or milling machine.

Module - 2: Fitting shop

Typical jobs that may be made in this practice module: To make a Gauge from MS plate.

Module - 3: Carpentry Shop

Typical jobs that may be made in this practice module: To make wooden joints and/or a

pattern or like.

Module – 4: Welding & Soldering shop

Typical jobs that may be made in this practice module:

i. Arc Welding: To join two thick (approx5mm) MS plates by manual metal arc welding.
ii. Gas Welding: To join two thin mild steel plates or sheets by gas welding.
iii. House wiring, soft Soldering

Module – 5: Smithy & Casting

Typical jobs that may be made in this practice module:

i. A simple job of making a square rod from around bar or similar.
ii. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module – 6: CNC Machining & Laser Cutting

Typical jobs that may be made in this practice module:

i. At least one sample shape on mild steel plate should be made using CNC Milling / CNC Lathe Machine
ii. At least one sample shape on glass should be made using laser cutting machine.

Module – 7: 3D Printing

i) Exposure to a 3D printing machine,
ii) 3D printing of at least one sample model using available materials.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K. –Elements of Workshop Technology, Vol-I 2008 and Vol-II 2010, Media promoters and publishers private limited, Mumbai.
2. Rao P.N. –Manufacturing Technology, Vol - I and Vol - II, Tata McGraw Hill House, 2017.

Reference Books:

1. Gowri P, Hariharanand A., Suresh Babu, ManufacturingTechnology – I, Pearson Education, 2008.
2. Roy A. Lindberg –Processes and Materials of Manufacture, 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A. Ghosh and A.K. Mallick,Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C. Sen and A. Bhattacharya, New Central Book Agency, Kolkata.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	2	-	2	2	-	-
CO2	3	-	-	-	-	-	2	-	2	2	-	-
CO3	3	-	-	-	-	-	2	-	2	2	-	-
CO4	3	-	-	-	-	-	2	-	2	2	-	-
CO5	3	2	2	-	-	-	2	-	2	2	-	-
Avg.	3	2	2	-	-	-	2	-	2	2	-	-

1st Year 2nd Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME201	Bioelectronics	3	0	0	3	3
2	ENGG	Minor	CS(BME)201	Programming for Problem Solving	3	0	0	3	3
3	SCI	Multidisciplinary Course	PH(BME)201	Engineering Physics	3	0	0	3	3
4	SCI	Multidisciplinary Course	M(BME)201	Engineering Mathematics - II	3	0	0	3	3
5	HUM	Value Added Course	HU204	Environmental Science	2	0	0	2	2
6	HUM	Value Added Course	HU205	Indian Knowledge System	1	0	0	1	1
B. Practical									
7	ENGG.	Major	BME291	Bioelectronics Lab	0	0	3	3	1.5
8	ENGG.	Minor	CS(BME)291	Programming for Problem Solving Lab	0	0	3	3	1.5
9	SCI	Skill Enhancement Course	PH(BME)291	Engineering Physics Lab	0	0	3	3	1.5
10	ENGG.	Skill Enhancement Course	ME(BME)291	Engineering Graphics and Design Lab	0	0	3	3	1.5
11	HUM	Ability Enhancement Course	HU(BME)291	Skill Development – I: Competencies in Social Skills	0	0	2	2	1
Total of Theory and Practical Courses								**29**	**22**

A. Theory

COURSE NAME: BIOELECTRONICS
COURSE CODE: BME201
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fundamental knowledge of Physics and Mathematics.

Course Outcomes:

After completion of this course, students will be able to

CO1: Illustrate the basic components, circuits and devices of electrical and electronics engineering.

CO2: Apply the concept of diode in rectifiers, filters circuits and wave shaping.

CO3: Implement the simple circuits like amplifiers, integrator and differentiator using OPAMPS and BJT**.**

CO4: Integrate the knowledge of electronic systems into medical field.

Course Content:

Module- 1: Basic Circuits Concepts **7L**

Passive components: Resistance, Inductance, Capacitance; series, parallel combinations; Kirchhoff's law: Voltage, Current; Linearity; Signal sources: Voltage and Current sources; Non-ideal sources; concept of Gain, Trans-conductance, Trans-impedance; Introduction to Filters (LPF, BPF & HPF); Working Principle of Transformer.

Module- 2: Diodes and Transistors **8L**

Semiconductor; P-N Junction Diode Characteristics, Diode applications: Clipper; Clamper circuits, Zener diode, LED, Photodiode; Rectifier; Half wave, Full wave (center-tapped, bridge), Regulated power supply.

BJT configuration and Characteristics (Common Emitter, Common Base, Common Collector), Transistor as an amplifier, Transistor biasing- basic idea,Thermal compensation, Construction and working principle of JFET and MOSFET.

Module- 3: The Operational Amplifier and Oscillator **8L**

Basic feedback theory; positive and negative feedback; Advantages of negative feedback.

Ideal OPAMP characteristics; Virtual ground concept; Inverting Amplifier, Non-inverting Amplifier, Adder, Subtractor.

Oscillator- Concept of Tank circuit; Barkhausen criteria; Type of Oscillator- Basics of RC, LC and Crystal Oscillator.

Module- 4: Networking System **8L**

Introduction, Wired and Wireless Communication system, LAN, MAN, WAN, Internet/Intranet, Transmission media, OSI model, Modem, Switch, IP Address, Router, Bluetooth.

Module- 5: Application of Bioelectronics System **5L**

Bioinstrumentation system: Transducer, Strain Gauge; Remote Monitoring, Physiological Parameter Monitoring, Audio-Video System; Telemedicine.

Text Books:

1. D. Chattopadhyay, P C Rakshit: Electronics Fundamentals and Applications, New Age International.
2. Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
3. E. Hughes: "Electrical and Electronics Technology", Pearson, 2010.
4. BL Theraja & AK Theraja: Textbook of electrical technology. S. Chand Limited, 2006.

Reference Books:

1. John D. Ryder, Electronic Fundamentals and Applications, PHI
2. Sandro Carrara, Krzysztof Iniewski (Eds.): Handbook of Bioelectronics- Directly Interfacing Electronics and Biological Systems. Cambridge University Press, September 2015.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**2**
CO4	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
Avg.	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: PROGRAMMING FOR PROBLEM SOLVING
COURSE CODE: CS(BME)201
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fundamentals of Computer.

Course Outcomes:

After completion of this course, students will be able to

CO1: Identify the working principle of input and output devices of Computers memorize the basic terminology used in computer programming.

CO2: Express programs in C language and use different data types for writing the programs.

CO3: Implement programs using the dynamic behaviour of memory by the use of pointers.

CO4: Explain the difference between call by value and call by address.

CO5: To write programs using basic data files and developing applications for real world problem

Module-1: Fundamentals of Computer **9L**

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices.

Number System: basic of Binary, Octal, Decimal and Hexadecimal number systems; Representation and inter changing of number in different number systems. Introduction to complements system, Representation of signed and unsigned numbers in singed magnitude singed 1's complement system and signed 2's complement system.

Arithmetic: Addition and Subtraction (using1's complement and 2's complement). Representation of Characters-ASCII Code, Basics of Compiler, Interpreter and Assembler.

Problem solving - Basic concept of Algorithm. Representation of algorithm using flowchart and pseudo code, Some basic examples.

Module-2: Introduction to C Programming **5L**

Overview of Procedural vs Structural language; History of C Programming Language. Variable and Data Types: The C characters' identifiers and keywords, data type & sizes, variable names, declaration, statements.

Operators & Expressions: Arithmetic operators, relational operators, Logical operators, increment and decrement operators, bitwise operators, Assignment operators, conditional operators, special operators-type conversion, C expressions, precedence and associativity.

Input and Output: Standard input and output, formatted output - print f, formatted input scan f.

Module-3: Branch and Loop **5L**

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else ladder. Switch Case: break and continue; switch-case, concept of go to and labels.

Loops- while, for, do while

Module- 4: Program Structures ` 4L

Function: Basics of Functions, function types, function prototypes, formal and actual parameter, function calling, functions returning values, functions not returning values. Recursion and Recursive Function.
Storage Class in C: Storage Class-auto, external, static and register storage class, scope rules and lifetime of variables
C pre-processor: Pre-processing directive and macro, parameterized macro.

Module-5: Array and Pointer 7L

Arrays: One dimensional arrays, Two-dimensional arrays
Passing an array to a function Pointers: Pointers, Pointer and Array, Pointer and functions.
Strings: Character array and string, array of strings, Passing a string to a function, String related functions, Pointer and String.
Dynamic memory allocation: Malloc, calloc, realloc and free with example.

Module-6: Structures, Unions and Enum 3L

Basic of structures, arrays of structures, structures and pointers, bit fields. Basics of union and enum, difference between structure and union.

Module-7: File in C 3L

Files handling-opening and closing a file in different mode, formatted and unformatted files, Command line arguments, fopen, fclose, fgetc, fputc, fprintf, fscanf function.

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. Kanetkar Y., Let us C, BPB Publication,15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India
2. K R Venugopal & S R Prasad– MASTERINGC, TMH, 2nd Edition

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P011
CO1	3	3	3	2	2	-	-	-	-	-	2	3
CO2	2	2	3	3	3	-	-	-	-	-	-	3
CO3	2	3	2	2	2	-	-	-	-	-	-	3
CO4	3	2	2	3	3	-	-	-	-	-	-	2
CO5	2	2	2	1	1	-	-	-	-	-	2	3
Avg.	2.4	2.4	2.4	2.2	2.2	-	-	-	-	-	2	2.8

COURSE NAME: ENGINEERING PHYSICS
COURSE CODE: PH(BME)201
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Pre requisite: Knowledge of Physics up to 12th standard.

Course Outcomes:

After completion of this course, students will be able to

CO1: Explain basic principles of laser, optical fiber and holography.

CO2: Explain the basic principles of production of ultrasound and applications in different engineering fields.

CO3: Understand the properties of Nanomaterial and semiconductor.

CO4: Analyze different crystallographic structures according to their co-ordination number and packing factors.

CO5: Justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics.

Course Content:

Module- 1: Modern Optics **12L**

1.01- Laser: Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. **6L**

1.02-Fibre Optics-Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. **3L**

1.03-Holography-Theory of holography, viewing of holography, applications **3L**

Module- 2: Solid State Physics **6L**

2.01 Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices – Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. **3L**

2.02 Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. **3L**

Module - 3: Quantum Mechanics **8L**

3.01 Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group

velocity; de Broglie hypothesis; Davisson and Germer experiment, related numerical problems. **4L**

3.02 Quantum Mechanics: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions-Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement). **4L**

Module- 4: Physics of Nanomaterials **4L**

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, graphene, electronic, environment, medical).

Module-5: Ultrasound and X Rays **6L**

5.01 Ultrasound and Infrasound **3L**

Ultrasound-Introduction, definition and properties –Production of ultrasonics by Piezoelectric crystal and magnetostriction method; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing, cavitations, measurement of gauge)

5.02 X Rays **3L**

Origin of X-Rays, X-Ray spectrum, Moseley's Law, Absorption of X-Ray by a material, Applications of X-Ray

Text Books:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers).
2. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers).
3. Perspective & Concept of Modern Physics -Arthur Baiser (Publisher: MaGrawhill)
4. Principles of engineering physics – Md. N Khan and S Panigrahi (Cambridge University Press).
5. Concepts of Modern Engineering Physics-A. S. Vasudeva. (S. Chand Publishers)
6. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers).
7. Physics Volume 1&2 -Haliday, Resnick & Krane, Publisher: Wiley India).
8. Engineering Physics-B. K. Pandey And S. Chaturvedi (Publisher: Cengage Learning, New Delhi).

Reference Books:

Modern Optics:

1. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers).
2. Optics-Ajay Ghatak (TMH)

Solid State Physics:

1. Solid state physics- S. O. Pillai.
2. Introduction to solid state physics-Kittel (TMH).

Quantum Mechanics:

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House).
2. Quantum mechanics -A.K. Ghatak and S Lokenathan

Physics of Nanomaterials

1. Introduction to Nanotechnology, B.K. Parthasarathy.
2. Introduction to Nanoscience and Nanotechnology, An Indian Adaptation-Charles P. Poole, Jr., Frank J. Owens.

Ultrasound and Infrasound

1. Principles of Accoustics-B. Ghosh (Sreedhar Publishers)
2. A Treatise on Oscillations, Waves and Acoustics-D. Chattopadhyay
3. Acoustics By D. P. Chattopadhyay

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Avg.	**3**	**2.8**	**2.2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1.6**

COURSE NAME: ENGINEERING MATHEMATICS - II
COURSE CODE: M(BME)201
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: The students to whom this course will be offered must have the concept of (10+2) standard calculus.

Course Outcomes:

After completion of this course students will be able to

CO1: Recall the properties related to ordinary differential equations, partial differential equations and Laplace transform.

CO2: Determine the solutions of the problems related to ordinary differential equations, partial differential equations and Laplace transform.

CO3: Apply appropriate mathematical tools of ordinary differential equations, partial differential equations and Laplace transform.

CO4: Analyze engineering problems by using ordinary differential equations, partial differential equations and Laplace transform.

Course Content:

Module I: First Order Ordinary Differential Equations (ODE) 9L

***Solution of first order and first degree ODE*:** Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation.
Solution of first order and higher degree ODE: solvable for p, solvable for y and solvable for $x$and Clairaut's equation.

Module II: Second Order Ordinary Differential Equations (ODE) 8L

Solution of second order ODE with constant coefficients: C.F. &P.I., Method of variation of parameters, Cauchy-Euler equations.

Module III: Partial Differential Equations 6L

***Solution of PDE*:** Method of Separation of variables.
***Solution of Initial Value & Boundary Value Problem*:** One Dimensional Wave Equation, One *Dimensional Heat Equation, Two-Dimensional Laplace Equation.*

Module III: Laplace Transform (LT) 13L

Concept of improper integrals; Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $tf(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties, Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
6. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
7. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
8. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
9. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
10. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Avg.	**2.75**	**2.25**	**1.5**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.25**

COURSE NAME: ENVIRONMENTAL SCIENCE
COURSE CODE: HU204
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisite: None

Course Outcomes:

After completion of this course students will be able to

CO1: Understand the natural environment and its relationships with human activities

CO2: The ability to apply the fundamental knowledge of science and engineering to assess environmental and health risk

CO3: Ability to understand environmental laws and regulations to develop guidelines and procedures for health and safety issues.

CO4: Acquire skills for scientific problem-solving related to air, water, noise & land pollution.

Course Content:

Module-1: Resources and Ecosystem **6L**

Resources **2L**

Types of resources, resistance to resources, Human resource, Population Growth models: Exponential Growth, logistic growth

Ecosystem **3L**

Components of ecosystem, types of ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Food chain, Food web.

Energy and Environment **1L**

Conventional energy sources, coal and petroleum, Green energy sources, solar energy, tidal energy, geothermal energy, biomass

Module- 2: Environmental Degradation **9L**

Air Pollution and its impact on Environment **3L**

Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

Water Pollution and its impact on Environment **3L**

Water Pollutants, Oxygen demanding wastes, heavy metals, BOD, COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal poisoning and toxicity.

Land Pollution and its impact on Environment **2L**

Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes

Noise Pollution and its impact on Environment **1L**

Types of noise, Noise frequency, Noise pressure, Noise intensity, Noise Threshold limit, Effect of noise pollution on human health.

Module-3: Environmental Management **6L**

Environmental Impact Assessment **1L**

Objectives of Environmental management, Components of Environmental Management, Environmental Auditing, Environmental laws and Protection Acts of India

Pollution Control and Treatment **2L**

Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator, etc., Waste Water Treatment, Noise pollution control.

Waste Management **3L**

Solid waste management, Open dumping, Land filling, incineration, composting, E-waste management, Biomedical Waste management.

Module- 4: Disaster Management **3L**

Study of some important disasters **2L**

Natural and Man-made disasters, earthquakes, floods drought, landside, cyclones, volcanic eruptions, tsunami, Global climate change. Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

Disaster management Techniques **1L**

Basic principles of disasters management, Disaster Management cycle, Disaster management policy, Awareness generation program.

Text Books:

1. Basic Environmental Engineering and Elementary Biology (For MAKAUT), Gourkrishna Dasmohapatra, Vikas Publishing.
2. Basic Environmental Engineering and Elementary Biology, Dr. Monindra Nath Patra & Rahul Kumar Singha, Aryan Publishing House.
3. Textbook of Environmental Studies for Undergraduate Courses, Erach Barucha for UGC, Universities Press.

Reference Books:

1. A Text Book of Environmental Studies, Dr. D.K. Asthana & Dr. Meera Asthana, S.Chand Publications.
2. Environmental Science (As per NEP 2020), Subrat Roy, Khanna Publisher

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	2	3	3	-	-	1	2
CO2	3	3	3	1	1	2	3	3	-	-	1	2
CO3	3	3	3	2	1	2	3	3	-	-	1	2

CO4	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**-**	**-**	**1**	**2**
Avg.	**2.25**	**2.25**	**2.5**	**1.33**	**1.33**	**2**	**3**	**3**	**-**	**-**	**1**	**2**

COURSE NAME: INDIAN KNOWLEDGE SYSTEM
COURSE CODE: HU205
CONTACT: 1:0:0
TOTAL CONTACT HOURS: 12
CREDIT: 1

Prerequisite: None

Course Outcomes:

After completion of this course students will be able to

CO1: Recall & state thought process of social setting in ancient India to identify the roots and details of some contemporary issues faced by Indians

CO2: Identify & inspect the importance of our surroundings& culture to design & formulate sustainable developmental solutions

CO3: Develop the ability to understanding the issues related to 'Indian' culture, tradition and its composite character to apply the same in the socio-technological developments in present scenario

CO4: Relate & assess Indian Knowledge System in the health care, architecture, agriculture & other systems.

Course Content:

Module-1: An overview of Indian Knowledge System (IKS) 3L

Importance of Ancient Knowledge, Definition of IKS, Classification framework of IKS, Unique aspects of IKS.
The Vedic corpus: Vedas and Vedangas, Distinctive features of Vedic life.
Indian philosophical systems: Different schools of philosophy.

Module-2: Salient features of the Indian numeral system 3L

Importance of decimal representation, the discovery of zero and its importance, Unique approaches to represent numbers.
Highlights of Indian Astronomy: Historical development of astronomy in India.

Module-3: Indian science and technology heritage 3L

Metals and metal working - Mining and ore extraction –Physical structures in India - Irrigation and water management - Dyes and painting technology - Surgical Techniques – Ship building .

Module-4: Traditional Knowledge in Different Sectors 3L

Traditional knowledge and engineering, Traditional medicine system, Traditional Knowledge in agriculture, Traditional societies depend on it for their food and healthcare needs.

Text Books:

1. Introduction to Indian knowledge system: concepts and applications- Mahadevan B. Bhat, Vinayak Rajat, Nagendra Pavana R.N., PHI.

Reference Books:

1. Traditional Knowledge system in India, Amit Jha, Atlantic Publishers

2. S. N. Sen and K. S. Shukla, *History of Astronomy in India*, Indian National Science Academy, 2nd edition, New Delhi, 2000.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	3	-	3	-	2	3	1	-	2
CO2	-	-	2	-	-	3	3	2	3	3	-	-
CO3	-	-	2	-	-	3	3	1	3	1	-	2
CO4	-	-	2	-	-	3	3	2	3	-	-	-
Avg.	-	-	2	3	-	3	3	1.75	3	1.67	-	2

B. Practical

COURSE NAME: BIOELECTRONICS LAB
COURSE CODE: BME291
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of Physics and Mathematics.

Course Outcomes:

After completion of this course, students will be able to

CO1: Identify various electronic components and fundamental operation of electrical and electronic devices.

CO2: Illustrate the characteristic features of different electronic devices such as diode, transistors etc., and simple circuits like rectifiers, amplifiers etc.

CO3: Determine the Gain of various types of amplifiers.

CO4: Design simple circuits like voltage regulator, half wave and full wave rectifier, amplifiers etc.

List of Experiments:

1. Identification of Various active and passive electronic components.
2. Operation and Implementation of Multimeter, Function Generator, DC Power supply, Oscilloscope etc.
3. V-I Characteristics of P-N Junction Diode
4. Design of Clipper and Clamper Circuit using Diode
5. Study on Zener Diode as a voltage regulator
6. Design a Half wave and Full wave rectifier
7. Study on input-output characteristics of Common Base mode.
8. Study on input-output characteristics of Common Emitter mode.
9. Characteristics of JFET and MOSFET
10. Calculation of Gain of Inverting Amplifier and Non-Inverting Amplifier
11. Innovative experiment

Text Books/ Reference Books:

1. Zbar Paul, Basic Electronics: A Text Lab Manual. Tata McGraw Hill, 2001.
2. Introductory Bioelectronics - For Engineers and Physical Scientists

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	3	2	2	2	2	-	-	-	-	-	-	2
CO3	3	2	3	-	-	-	-	-	2	-	-	1

CO4	**3**	**2**	**3**	**2**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**2**
Avg.	**3**	**2**	**2.5**	**2**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**1.75**

COURSE NAME: PROGRAMMING FOR PROBLEM SOLVING LAB
COURSE CODE: CS(BME)291
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: None

Course Outcomes:

After completion of this course, students will be able to

CO1: Identify the working of different operating systems like DOS, Windows, Linux

CO2: Express programs in C language

CO3: Implement programs connecting decision structures, loops

CO4: Experiment with user defined functions to solve real time problems

CO5: Write C programs using Pointers to access arrays, strings, functions, structures and files

Course Content:

Module - 1: Familiarization with some basic commands of DOS and Linux

File handling and Directory structures, file permissions, creating and editing simple C program in different editor and IDE, compilation and execution of C program. Introduction to Code block.

Module - 2: Problem based on

a. Basic data types
b. Different arithmetic operators.
c. printf() and scanf() functions.

Module - 3: Problem based on conditional statements using

a. if-else statements
b. different relational operators
c. different logical operators

Module - 4: Problem based on

a. **for** loop
b. **while** loop
c. **do-while** loop

Module - 5: Problem based on

a. How to write a menu driven program using switch-case statement
b. How to write a function and passing values to a function
c. How to write a recursive function

Module - 6: Problem based on

a) How to use array (both 1D and 2D)
b) How to pass an array to a function

Module - 7: Problem based on

a. Manipulation of strings in different way.

Module - 8: Problem based on

b. How to handle compound variables in C
c. How to handle file in C
d. How to use command line argument in C

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. Kanetkar Y., Let us C, BPB Publication, 15th Edition.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. KR Venugopal & SR Prasad–MASTERING C, TMH, 2nd Edition.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**2**	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO3	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO5	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**2.4**	**2.4**	**2.4**	**2.2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**2**	**2.8**

COURSE NAME: ENGINEERING PHYSICS LAB
COURSE CODE: PH(BME)291
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Knowledge of Physics up to 12^{th} standard.

Course Outcomes:

After completion of this course, students will be able to

CO1: Demonstrate experiments allied to their theoretical concepts.

CO2: Conduct experiments using LASER, Optical fiber.

CO3: Participate as an individual, and as a member or leader in groups in laboratory sessions actively

CO4: Analyze experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiment.

CO5: Design solutions for real life challenges.

Course Content:

General idea about Measurements and Errors (One Mandatory):

i) Error estimation using Slide callipers/ Screw-gauge/travelling microscope for one experiment.

Experiments on Classical Physics (Any 4 to be performed from the following experiments):

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.
6. Optical Fibre-numerical aperture, power loss.

Experiments on Quantum Physics (Any 2 to be performed from the following experiments):

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.
10. Study of characteristics of solar cell.

Perform at least one of the following experiments:

11. Determination of Q factor using LCR Circuit.
12. Study of I-V characteristics of a LED/LDR

**In addition it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Probable experiments beyond the syllabus:

1. Study of dispersive power of material of a prism.
2. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.

3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

Text Books for Engineering Physics Lab:

Waves & Oscillations:

Vibration, Waves and Acoustics- Chattopadhyay and Rakshit Classical & Modern

Optics:

A text book of Light- K.G. Mazumder & B.Ghosh (Book & Allied Publisher)

Quantum Mechanics - I

Introduction to Quantum Mechanics - S. N. Ghoshal (Calcutta Book House)

Solid State Physics:

Solid State Physics and Electronics - A. B. Gupta and Nurul Islam (Book & Allied Publisher)

Text Books:

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing)
3. Practical Physics by R. K. Kar (Book & Allied Publisher)

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Avg.	**2**	**2.6**	**2.4**	**2.6**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: ENGINEERING GRAPHICS AND DESIGN LAB
COURSE CODE: ME(BME)291
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Basic knowledge of geometry.

Course Outcomes:

After completion of this course, students will be able to

CO1: Get introduced with Engineering Graphics and visual aspects of design**.**

CO2: **K**now and use common drafting tools with the knowledge of drafting standards.

CO3: Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints.

CO4: Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.

Course Content:

Basic Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module - 1: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involutes; Scales–Plain, Diagonal and Vernier Scales.

Module - 2: Orthographic & Isometric Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module - 3: Sections and Sectional Views of Right Angular Solids

Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module - 4: Overview of Computer Graphics

Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify

and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module - 5: CAD Drawing, Customization, Annotations, layering

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wire frame modeling, Part editing and printing documents.

Module - 6: Demonstration of a simple team design project

Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K.Venugopal, Engineering Drawing + AutoCAD, New Age International publishers.

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & PKannaiah (2008), Textbook on Engineering Drawing, Scitech Publishers.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	2	2	2	-	2	2	2	2
CO2	2	2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	3	2	3	2	2	-	2	2	2	3
CO4	2	2	3	3	3	3	2	2	3	3	2	2
Avg.	2	2	3	2.25	2.5	2.25	2	2	2.25	2.25	2	2.25

2nd Year 3rd Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME301	Human Anatomy and Physiology	3	0	0	3	3
2	ENGG.	Major	BME302	Biomechanics - I	3	0	0	3	3
3	ENGG.	Minor	EE(BME)301	Circuit Theory and Networks	3	0	0	3	3
4	ENGG.	Minor	M(BME)301	Numerical Methods and Statistics	3	0	0	3	3
5	ENGG.	Minor	EC(BME)301	Analog Electronics	3	0	0	3	3
B. Practical									
6	ENGG.	Major	BME391	Human Anatomy and Physiology Lab	0	0	3	3	1.5
7	ENGG.	Skill Enhancement Course	EE(BME)391	Circuit Theory and Networks Lab	0	0	2	2	1
8	ENGG.	Minor	M(BME)391	Numerical Methods and Statistics Lab	0	0	2	2	1
9	ENGG	Skill Enhancement Course	EC(BME)391	Analog Electronics Lab	0	0	3	3	1.5
10	HUM	Ability Enhancement Course	HU391	Skill Development – II: Technical seminar Presentation	0	0	2	2	1
Total of Theory and Practical Courses								**27**	**21**

A. Theory

COURSE NAME: HUMAN ANATOMY AND PHYSIOLOGY
COURSE CODE: BME301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Basic knowledge of Biology (Physiology Section)

Course Outcomes:

After completion of this course students will be able to

CO1: Illustrate the anatomy and physiology of various human organ systems.

CO2: Determine the corresponding structure function relationship of all organ systems and the mechanisms of function involved in physiological parameters.

CO3: Analyse the problems related to deformity or deviation from normal physiological processes in living systems.

CO4: Predict physiological abnormality and malfunctioning along with its impact on health, safety, environment and society.

CO5: Assess the deviation of physiological parameters and variables.

Course Contents

Module- 1: Blood Vascular System **6L**

Composition and functions of blood. Plasma proteins – normal values, origin and functions. Brief idea on Bone marrow. Formed elements of blood – origin, formation, functions and fate. Haemoglobin – functions, compounds and derivatives. Abnormal haemoglobin-overview. Erythrocyte sedimentation rate (ESR) and its significance. Haematocrit. PCV, MCV, MCH, MCHC. Blood coagulation –factors, process, anticoagulants, Prothrombin time. Clotting time. Bleeding time. Blood groups – ABO systems and Rh factors. Blood transfusion. Ultrastructure and functions of blood vessels (artery, vein, capillary). Differences between artery and vein.

Module- 2: Cardio Vascular System **6L**

Structure and function of Heart, Anatomical position, chambers of heart, Blood circulation through heart and. Special junctional tissue of heart. Cardiac cycle. Heart Sound. Systemic and pulmonary circulation. Cardiac output. Blood Pressure-regulation and controlling factors.

Module- 3: Muscular and Skeletal System **6L**

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. Difference between skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibres. Properties of muscle: excitability and contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period. Muscle contraction – E C Coupling, Muscle fatigue, Rigor mortis, Sliding filament theory, Slow and fast muscle fibres, Isotonic and Isometric contraction.
Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial

Joint, Cartilage, Tendon, Ligament

Module- 4: Renal System **4L**

Function of kidney, Anatomy and Histology of Nephron and collecting duct. Urine formation mechanism (Filtration, reabsorption and secretion). Acidification of Urine. Counter-current system of urine concentration, Typical anomalies in renal and excretory system.

Module- 5: Digestive System **4L**

Organization of GI system, Movement along GI tract, Function of Liver, Intestine and Pancreas, Digestion and Absorption, Role of Enzymes in Digestion.

Module- 6: Respiratory System **4L**

Respiratory Pathways, Mechanism of Respiration, Respiratory membrane and gaseous exchange, Lungs, Role of Lungs in Respiration and Thermoregulation. Oxygen and Carbon Dioxide Transport in Human Body.

Module- 7: Neuro Physiology **6L**

Overview of Nervous system- CNS, PNS, ANS, Structure and function of neurons. Types of nerve fibres. The action potential, neurotransmitters, Conduction velocity of nerve impulse. Neuromuscular Junction – structure, events in transmission, end-plate potential, post titanic potential. Synapses – types, structure, synaptic potentials, synaptic transmission of the impulse. Reflex Action.

Text Books:

1. Essential of Medical Physiology - Anil Baran Singha Mahapatra, Current Books International.
2. Human Physiology - C.C. Chatterjee, Medical Allied Agency.
3. Text book of Medical Physiology- Guyton.

Reference Books:

1. Concise Medical Physiology - Chauduri
2. Anatomy and Physiology – Ross and Wilson, Churchill Livingstone publications.
3. Modern Physiology and Anatomy for Nurses - J Gibson, Black-well Scientific Publishers.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	3	3	3	-	-	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	3	2	-	2
AVG.	3	3	3	3	3	-	-	-	3	2	-	2

COURSE NAME: BIOMECHANICS - I
COURSE CODE: BME302
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Basic knowledge of mechanics which includes kinetics and kinematics and human functional anatomy.

Course Outcomes:

After completion of the course students will be able to

CO1: Illustrate the fundamental concepts of human biomechanical system applying basic mechanics.

CO2: Determine the biomechanics of human joints considering the properties of hard and soft biological tissues and the forces responsible for static and dynamic human activities.

CO3: Analyze the gross movement and dynamics of the human body using appropriate engineering tools and suitable models.

CO4: Identify the problems and failure associated with the tissue biomechanics and how to solve such problems applying artificial implants.

Course Content

Module- 1: Introduction to Biomechanics 5L

Review of the principles of mechanics, Vector mechanics- Resultant forces of Co-planer and Non-co-planer and Concurrent and Non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia, Statics and Dynamics in Biomechanics.

Module- 2: Joint Biomechanics 6L

Analysis of rigid bodies in equilibrium, free body diagrams, Types of joints, Skeletal joints, forces and stresses in human joints, Biomechanical analysis of elbow, shoulder, hip, knee and ankle.

Module- 3: Tissue Biomechanics 7L

Constitutive Properties of Tissues, Structure and Mechanical Properties of Bone, Bone Mechanics and Remodelling- viscoelastic properties, Maxwell and Voight models – anisotropy. Electrical properties of bone. Structure, Functions, Mechanical Properties and Modelling of Collagen and Collagenous Tissues: Cartilage, Tendon, Ligament and Muscle**,** Testing of Collagenous Connective Tissues.

Module- 4: Movement Biomechanics 4L

Gait analysis, body and limbs: mass and motion characteristics actions, forces transmitted by joints. Joints forces results in the normal and disable human body, normal and fast gait on the level. Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Moment of inertia-

limb. Introduction of a modern GAIT lab.

Module- 5: Cardiac Biomechanics 4L

Cardiovascular system, Mechanical properties of heart (cardiac chambers and valves) and blood vessels (arteries, arterioles, capillaries and veins). Introduction to stent and Artificial heart valves, biological and mechanical valves development, testing of valves.

Module- 6: Implant Mechanics 5L

General concepts of Implants, classification of implants, Soft tissue replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of Orthopedic implant, Dental implant, Ocular implant etc. Specifications for a prosthetic joint, fixation of implants.

Module- 7: Problems and Failures associated with Biomechanics 5L

Wear and friction in joints, Fatigue, Creep, Stress concentration, Stress shielding, Bending and buckling, Types of fractures, biomechanics of fracture healing, types of fracture fixators.

Text Books:

1. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
2. Richard Shalak and Shu Chien, Handbook of Bioengineering,
3. Sean P. Flanagan, Flanagan, Biomechanics: A case-based Approach, Jones and Bartlett Publishers, 2013
4. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.

Reference Books:

1. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams and Wilkins, 2010
2. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones and Bartlett Publishers, 2013.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
4. White andPuyator, Biomechanics, Private publication UAE, 2010

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	3	3	3	2	-	-	-	-	-	-	2
Avg.	3	3	3	3	2	-	-	-	-	-	-	2

COURSE NAME: CIRCUIT THEORY AND NETWORKS
COURSE CODE: EE(BME)301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Fundamental knowledge of Integral & Differential Calculus, Laplace Theorem & its inverse and knowledge of DC & AC circuit parameters with passive & active circuit elements/components.

Course Outcomes:

After completion of this course the students will be able to

CO1: Use the basic concepts of electrical circuits and governing laws to solve complex networks.

CO2: Model complex electrical circuits graphically.

CO3: Apply the concept of magnetic and electromagnetic circuits to understand coupled circuits.

CO4: Examine resonating behavior of electric circuits.

CO5: Analyze transient and steady state behavior of electric networks using Laplace Transform method.

CO6: Develop fundamental circuitry for Biomedical instruments.

Course Content:

Module- 1: Introduction 8L

Concept of Resistance, Inductance, Capacitance, current source, voltage source, Source transformation, Series and parallel connection of Resistance, Inductance, Capacitance and related problem solution.Star-Delta transformations.
Mesh Current Network Analysis: Kirchoff's Voltage Law, Formulation of Mesh Equations, Solution of mesh equations by Cramer's rule and matrix method, Driving point impedance, Transfer impedance, Solutions of Problems with DC and AC sources
Node Voltage Network Analysis: Kirchoff's Current Law, Formulation of node equations and solutions, Driving point admittance, Transfer admittance, Solutions of Problems with DC and AC sources.

Module- 2: Network Theorems 5L

Definition and implications of Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Solutions and Problems with DC and AC sources.

Module- 3: Graph of Network 5L

Concept of Tree Branch, Tree link, junctions, Incident matrix, Tie-set matrix, Cut-set matrix, determination of loop current and node voltages.

Module- 4: Coupled Circuits and Resonant Circuits 6L

Coupled Circuits: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems.

Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics,

Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems.

Module- 5: Laplace Transform and Circuit Transients 9L

Laplace Transform: Concept of complex frequency, transformation of f(t) into F(s), transformation of step, exponential, over-damped surge, critically damped surge, damped sine, und-amped sine functions, properties of Laplace Transform, linearity, real differentiation, real integration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, solution of problems.

Circuit Transients: DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, AC transients in sinusoidal RL, R-C, & R-L-C circuits, solution of problems.

Module- 6: Typical circuits for Physiological Parameter measurements 3L

Basic techniques of low voltage low frequency biophysical signal measurement (ECG, EMG, EOG), impedance matching, patient safety & isolation. Introduction to bio-electrodes for specific applications.

Text Books:

1. Valkenburg M. E. Van, Network Analysis, Prentice Hall./Pearson Education
2. Hayt"Engg Circuit Analysis 6/e Tata McGraw-Hill
3. D.A.Bell- Electrical Circuits- Oxford
4. A.B.Carlson-Circuits- Cenage Learning
5. John Bird- Electrical Circuit Theory and Technology- 3/e- Elsevier (Indian Reprint)

Reference Books:

1. Skilling H.H.: "Electrical Engineering Circuits", John Wiley & Sons.
2. Edminister J.A.: "Theory & Problemsof Electric Circuits", McGraw-Hill Co.
3. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.
4. R.A.DeCarlo&P.M.Lin- Linear Circuit Analysis- Oxford
5. P.RameshBabu- Electrical Circuit Analysis- Scitech
6. Sudhakar: "Circuits &Networks:Analysis& Synthesis" 2/e TMH
7. M.S.Sukhija&T.K.NagSarkar- Circuits and Networks-Oxford
8. Sivandam- "Electric Circuits and Analysis", Vikas
9. V.K. Chandna, "A Text Book of Network Theory & Circuit Analysis",Cyber Tech
10. Reza F. M. and Seely S., "Modern Network Analysis", Mc.GrawHill .
11. M. H. Rashid:Introduction to PSpice using OrCAD for circuits and electronics, Pearson
12. Roy Choudhury D., "Networks and Systems", New Age International Publishers.
13. D.Chattopadhyay and P.C.Rakshit: "Electrical Circuits" New Age

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	3	-	-	-	-	-	-	-	-	-
Avg.	3	3	3	-	-	-	-	-	-	-	-	-

COURSE NAME: NUMERICAL METHODS AND STATISTICS
COURSE CODE: M(BME)301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic concept of (10+2) standard algebra and calculus.

Course Outcomes:

After completion of this course, students will be able to

CO1: Apply numerical approaches to obtain approximate solutions to intractable mathematical problems.

CO2: Apply the statistical approaches to determine distinctive measures dealing with real-world data.

CO3: Analyze the accuracy of the results gained through the numerical techniques.

CO4: Analyze the findings of mathematical models using the underlying principles of statistical approaches.

Course Content

Module-I: Errors in Numerical Calculation and Interpolation 7L

Errors in Numerical Calculation: Introduction to error analysis; Sources of error; Propagation of errors. **(2L)**

Interpolation: Difference operators, Newton forward and backward interpolation, Lagrange's interpolation, Newton's divided difference interpolation formula. **(5L)**

Module-II: Numerical Solution of Polynomial and Transcendental Equations 3L

Bisection method, Regula-Falsi, Newton-Raphson method.

Module-III: Numerical Integration 3L

Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.

Module-IV: Numerical solution of ordinary differential equation 3L

Euler's method, Modified Euler's method, Fourth order Runge-Kutta method.

Module- V: Descriptive Statistics 10L

Measures of Central Tendency: Mean, Median, Mode. **(4L)**

Measures of Dispersion: Range, Mean deviation, Variance, Standard deviation. **(2L)**

Correlation: Bivariate Data, Scatter Diagram, Methods of studying correlation – Karl-Pearson's coefficient of correlation. **(2L)**

Regression: Regression lines, Regression equations, Regression coefficients. **(2L)**

Module- VI: Inferential Statistics 10L

Sampling Theory: Random sampling, Parameter & Statistic, Standard error of statistic, Sampling distribution of sample mean and variance in random sampling from a normal distribution, Central limit theorem and related problems. **[5L]**

Estimation of Parameters: Unbiased and consistent estimators, Point estimation, Interval estimation, Maximum likelihood estimation of parameters (Binomial, Poisson and Normal), Confidence intervals and related problems. **[5L]**

Text Books:

1. Gupta, S. and Dey, S., *Numerical Methods*, Mc. Grawhill Education Pvt. Ltd.
2. Das, N. G., *Statistical Methods*, TMH.

Reference Books:

1. Scarborough, J. B., *Numerical Mathematical Analysis*. Oxford and IBH Publishing
2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. *Numerical Methods (Problems and Solution)*. New age International Publisher.
3. Sancheti, D. S. and Kapoor, V. K., *Statistics Theory*, Method & Application, Sultan Chand & sons, New Delhi.
4. Balagurusamy, E. *Numerical Methods*, Scitech. TMH.
5. Shastri, S. S. *Numerical Analysis*, PHI.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
Avg.	3	2.5	-	-	-	-	-	-	-	-	-	-

COURSE NAME: ANALOG ELECTRONICS
COURSE CODE: EC(BME)301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Basic knowledge about components (R, L, C). Network Theorems (Kirchhoff's law, Theremin's theorem, Norton's theorem, etc.). Basic knowledge about the operation of semiconductor devices (Diode, Transistor, JFET etc.), Basic idea of integrated circuits, and Voltage current equations. Basic knowledge of Differentiation, Integration, Differential equation, matrix, etc.

Course Outcomes:

After completion of this course students will be able to

CO1: Design small and large signal amplifiers using the fundamental knowledge of transistor.

CO2: Implement the feedback concept in different amplifiers and oscillators.

CO3: Analyze the performance of small and large signal amplifiers

CO4: Develop various applications using OP-AMP and multivibrators.

Course Content:

Module I: 10L

Rectifier and Single Stage Transistor Amplifier: Rectifier and filter, regulated power supply using Zener diode and IC, SMPS

Transistor Biasing techniques, Q-point & its Stability, Thermal Runaway, self-bias CE configuration, Bias Compensation techniques, and h-parameter model of transistors. Expression for voltage gain, current gain, input and output impedance, power gain, and Emitter follower circuit.

Multistage Amplifier: RC coupled amplifier, functions of all components, derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, bandwidth

Module II: 7L

Power Amplifiers: Class A, B Power amplifier – working principle, conversion efficiency.

Tuned amplifier.

FET Amplifiers: Operating principle of JFET. drain and transfer characteristics of JFET (n-channel and p-channel), MOSFET – working principle.

Module III: 6L

Feedback Amplifiers: Feedback concept, negative & positive feedback, Gain calculation for positive and negative feedback condition, Advantages of negative feedback circuit.

Oscillators: Barkhausen criterion, RC Oscillators-Phase shift and Wien bridge oscillators, LC Oscillator-Colpitts, Hartley's, and Crystal oscillators.

Module IV: **4L**

Multivibrators: Astable and Monostable operation using transistor and IC 555 timer.

Module IV: **9L**

Operational Amplifier & It's Applications: Configuration of inverting and non-inverting amplifier using Op-amp, virtual ground, closed loop voltage gains of inverting and noninverting amplifier, adder, subtracter, multiplier, integrator & differentiator circuit, Comparator & Schmitt Trigger, Low pass, high pass and band pass active filters.

Text Books:

1. Sedra & Smith-Microelectronic Circuits-Oxford Up
2. Millman & Halkais- Integrated Electronics, McGraw Hill.
3. Boylested & Nashelsky-Electronic Devices and Circuit Theory-Pearson/PHI
4. Rashid-Microeletronic Circuits-Analysis and Design- Thomson (Cenage Learning).
5. Franco- Design with Operational Amplifiers & Analog Integrated Circuits, 3/e, McGraw Hill.
6. Gayakwad R.A – OpAmps and Linear IC's, PHI

Reference Books:

1. Razavi- Fundamentals of Microelectronics-Wiley
2. J.B. Gupta- Electronic Devices and Circuits- S.K. Kataria & Sons
3. Malvino- Electronic Principles, 6/e, McGraw Hill

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	-	1	2
CO2	2	3	3	3	3	-	-	-	-	-	1	3
CO3	2	3	3	3	2	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	1	2
Avg.	2.5	3	3	3	2.75	-	-	-	-	-	1	2.25

B. Practical

COURSE NAME: HUMAN ANATOMY AND PHYSIOLOGY LAB
COURSE CODE: BME391
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of Biology (Physiology Section)

Course Outcomes:

After completion of this course students will be able to

CO1: Identify Histology to get hands on exposure of the gross and microscopic approach to Anatomy and Physiology of various tissues and organs.

CO2: Perform Haematological experiments using necessary lab tools to analyse the structure function relationship of human systems.

CO3: Conduct experiments on Blood Pressure, Physiological significance of ECG to interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

CO4: Investigate effectively physiological parameters, as an individual and as a team member, maintaining ethics of Physiology Laboratory practice.

List of Experiments:

1. Study on Compound Microscope.
2. Identification of fixed histological slides: Cerebellum, Cerebral cortex, Spinal cord, Renal tissues, Blood vessels (artery and vein), Skin, Tongue, Liver.
3. Hemoglobin estimation.
4. Determination of blood pressure.
5. Blood film making and identification of different blood corpuscle.
6. ECG wave identification and study of physiological significance of the ECG wave.
7. Determination of Blood Group (ABO; Rh).
8. Measurement of Bleeding Time (BT) and Clotting Time (CT).
9. DC of WBC.
10. Innovative experiments.

Text Books/ Reference Books:

1. Essentials of Human Anatomy andamp; Physiology Laboratory Manual, 7th edition. Elaine N Marieb; Pamela B. Jackson. Pearson Publication

2. diFiore's Atlas of Histology with Functional Correlations, 12th International Edition. Victor P. Eroschenko. Publisher-Lippincott Williams and Wilkins

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	-	-	-	3	3	-	3
CO2	3	3	-	2	2	3	-	3	3	3	-	3
CO3	3	3	-	3	2	3	-	3	3	3	-	3
CO4	3	3	-	3	2	-	-	-	3	3	-	3
AVG.	3	3	-	2.5	2	3	-	3	3	3	-	3

COURSE NAME: CIRCUIT THEORY AND NETWORKS LAB
COURSE CODE: EE(BME)391
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Basic knowledge of operation and application of different passive and active circuit elements/components as well as analog & digital signal. In depth knowledge on Integral & Differential Calculus and Laplace Theorem & its inverse.

Course Outcomes:

After completion of this course students will be able to

CO1: Develop series and parallel RLC circuits using MATLAB to analyze their resonating behavior.

CO2: Analyze transient behavior of switching networks using MATLAB.

CO3: Use MATLAB to generate different analog and digital signals.

CO4: Design complex electrical networks and solve them using different network theorems.

List of Experiments

Implementation of Following Experiments using Software (MATLAB) or Hardware

1. Characteristics of Series & Parallel Resonant circuits
2. Verification of Network Theorems
3. Transient Response in R-L & R-C Networks; simulation / hardware
4. Transient Response in RLC Series & Parallel Circuits & Networks; simulation / hardware
5. Determination of Impedance (Z), and Admittance (Y) parameters of Two-port networks
6. Generation of periodic, exponential, sinusoidal, damped sinusoidal, step, impulse, and ramp signals.
7. Representation of Poles and Zeros in s-plane, determination of partial fraction expansion in s-domain.
8. Determination of Laplace Transform, different time domain functions, and Inverse Laplace Transformation.
9. Innovative experiments

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	-	3	-	-	-	-	-	-	-
CO2	3	3	-	-	3	-	-	-	-	-	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-
CO4	3	-	3	-	-	-	-	-	-	-	-	-
AVG.	3	3	3	-	3	-	-	-	-	-	-	-

COURSE NAME: NUMERICAL METHODS AND STATISTICS LAB
COURSE CODE: M(BME)391
CONTACT: 0:0:2
CREDITS: 1

Prerequisites: Basic concept of any introductory course on programming language (C/ MATLAB).

Course Outcomes:

After completion of this course students will be able to:

CO1: Apply the programming skills to solve the mathematical problems using numerical techniques and statistical approaches.

CO2: Analyze and interpret the results gained through numerical and statistical approaches using command.

CO3: Judge the multiple numerical approaches in terms of their accuracy level.

CO4: Design and develop effective programs for numerical and statistical approaches to solve the engineering problems.

List of Experiments:

1. Assignments on Newton forward /backward, Lagrange‘s interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson‘s 1/3 rule, Weddle’s Rule.
3. Assignments on numerical solution of Algebraic Equation by Bisection method, Regula-Falsi method, Newton-Raphson method.
4. Assignments on ordinary differential equation: Euler‘s method, Euler‘s Modified Method, Runge-Kutta Method.
5. Assignments on Mean, Median, Mode, Variance, Standard Deviation.
6. Assignments on Correlation and Regression.

Implementation of numerical methods and statistics through Software Packages: C / Matlab / Python / Scilab / Labview / Mathematica / NAG (Numerical Algorithms Group / Python).

Text Books:

1. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., *Numerical Methods: For Scientific and Engineering Computation*, New age International Publisher.
2. Pal, M., C Programming: Including Numerical and Statistical Methods, Alpha Science International Ltd

Reference Books:

1. Dutta, N. *Computer Programming & Numerical Analysis*, Universities Press.
2. Xavier, C., *C Language and Numerical Methods*, New age International Publisher.
3. Navidi, W., *Statistics for Engineers and Scientists*, McGraw Hill.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-
AVG.	3	2.25	3	-	-	-	-	-	-	-	-	-

COURSE NAME: ANALOG ELECTRONICS LAB
COURSE CODE: EC(BME)391
CONTACT: 0:0:2
CREDITS: 1

Prerequisites: A basic course in Electronics Engineering Progresses from the fundamentals of electricity, active and passive components, basic electronics laws.

Course Outcome:

After completion of this course students will be able to

CO1: Design transistor based single stage R-C coupled voltage amplifier and different classes of power amplifier circuit with given specification.

CO2: Design transistor-based oscillator circuit with a specified frequency.

CO3: Construct the astable and mono-stable mode timer circuit using IC 555.

CO4: Design different mathematical operational circuits and filtering circuits using OP-AMP

List of Experiments:

1. Design a voltage regulator using IC.
2. Study of single stage voltage amplifier & study of its frequency response.
3. Design of RC coupled amplifier in CE mode & study of its frequency response using BJT.
4. Design of class A power amplifier and measurement of its power conversion efficiency.
5. Design of class B amplifier and measurement of its power conversion efficiency.
6. Design an astable multivibrators circuit using IC 555.
7. Design of RC Phase shift oscillator using BJT and measurement of its output frequency.
8. Design of Integrator using OPAMP (IC-741) and study of its output waveform.
9. Design of Differentiator using OPAMP (IC-741) and study of its output waveform.
10. Design of low pass filter using OPAMP and study of its frequency response.
11. Innovative experiment

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	-	1	2
CO2	3	3	3	3	3	-	-	-	-	-	1	2
CO3	2	3	3	3	3	-	-	-	-	-	1	3
CO4	3	3	3	3	3	-	-	-	-	-	1	2
Avg.	2.75	3	3	3	3	-	-	-	-	-	1	2.25

2nd Year 4th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME401	Biomaterials	3	0	0	3	3
2	ENGG	Major	BME402	Biomechanics - II	3	0	0	3	3
3	ENGG	Major	BME403	Biophysical Signals and Systems	3	0	0	3	3
4	ENGG.	Minor	PH(BME)401	Medical Physics	2	0	0	2	2
5	ENGG	Minor	EC(BME)402	Digital Electronics and Devices	3	0	0	3	3
B. Practical									
6	ENGG.	Major	BME491	Biomaterials Lab	0	0	3	3	1.5
7	ENGG.	Major	BME492	Biomechanics Lab	0	0	3	3	1.5
8	ENGG.	Major	BME493	Biophysical Signals and Systems Lab	0	0	2	2	1
9	ENGG	Skill Enhancement Course	EC(BME)492	Digital Electronics and Devices Lab	0	0	2	2	1
10	HUM	Ability Enhancement Course	HU491	Skill Development – III: Analytical and Logical Thinking Skills - I	0	0	2	2	1
Total of Theory and Practical Courses								**26**	**20**

A. Theory

COURSE NAME: BIOMATERIALS
COURSE CODE: BME401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of Chemistry, Physics and Human Physiology.

Course Outcomes:

After completion of this course students will be able to

CO1: Explain the concepts of atomic structure, bonding, crystalline structures, defects and their impact on biomaterials.

CO2: Correlate structure, properties and applications of different types of biomaterials: metals, polymers, ceramics and composites.

CO3: Analyse the physiological deformity and deviation to select biomaterials for the fabrication of implants and prosthesis following regulations, standards and ethics.

CO4: Illustrate implant design process, real-life hurdles and reasons for failure of implants.

Course Content:

Module- 1: Basics of Biomaterials **6L**

Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

Module- 2: Metallic Biomaterials **6L**

Stainless steel, Titanium and its alloys, Cobalt based alloy, Dental metals, Dental amalgam, Gold, Nickel, and Corrosion of the metals. Hard tissue replacement materials: Orthopedic implants, Dental implants. Soft tissue replacement materials: Percutaneous and skin implants, Vascular implants, Heart valve implants.

Module- 3: Polymeric Biomaterials **6L**

Polymerization and basic structure, Classification according to thermosets, thermoplastics and elastomers; Bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Biocompatibility of polymers, blood compatibility improvement, processing techniques for the polymers, Applications of polymers in medical field.

Module- 4: Ceramic Biomaterials **6L**

Definition of bio-ceramics, Common types of bio-ceramics: Aluminium oxides, Glass ceramics, Carbons.Bio-inert Ceramics: Alumina, Carbon, Zirconia; Biodegradable Ceramics: Tri-Calcium

phosphate, Aluminum-Calcium-Phosphate (ALCAP) Ceramics; Bioactive ceramics: Bio-glass, Hydroxyapatite, Importance of wear resistance and low fracture toughness, Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/ bone tissue reaction), Medical applications**.**

Module- 5: Composite Biomaterials 4L

Properties and types of composites, Mechanics of improvement of properties by incorporating different elements, Composite theory of fiber reinforcement (short and long fibers, fibers pull out), Polymers filled with osteogenic fillers (Ex- Hydroxyapatite), Clinical Applications.

Module- 6: Biocompatibility and toxicological screening of biomaterials 5L

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity screening tests: acute and chronic toxicity studies (in situ implantation, tissue culture, hemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests). Standards and protocols applicable to biomaterials.

Module- 7: Sterilization of implantable biomaterials 3L

Dry heat, Autoclaving, ETO, Gamma radiation. Effects of sterilization on properties of various bio-materials.

Text Books:

1. J B Park, *Biomaterials - Science and Engineering*, Plenum Press, 1984.
2. Sujata V. Bhat, *Biomaterials*, Narosa Publishing House, 2002.
3. Bronzino JD, ed. The Biomedical Engineering Handbook, Second Edition, Vol-II, CRC Press

Reference Books:

1. Buddy D. Ratner, Allan S. Hoffman, Biomaterial Sciences – Int. to Materials in Medicine
2. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
3. C.P. Sharma and M. Szycher, *Blood compatible materials and devices*, Tech. Pub. Co. Ltd., 1991.
4. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers.
5. Eugene D. Goldbera , *Biomedical Ploymers*, Akio Nakajima.
6. L. Hench and E. C. Ethridge, *Biomaterials - An Interfacial approach*.\
7. Frederick H. Silver, Biomaterials, Medical devices and Tissue Engineering, Chapman and Hall.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**-**	**2**	**2**	**-**	**-**	**3**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
Avg.	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**3**	**-**	**-**	**-**	**2**

COURSE NAME: BIOMECHANICS - II
COURSE CODE: BME402
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of fluid mechanics, human circulatory system, cardiovascular & respiratory system, and joint biomechanics.

Course Outcomes:

After completion of the course student will be able to

CO1: Implement the different physical properties as well as the principles of motion for fluids towards physiological system.

CO2: Integrate various engineering aspects of fluid flow in human body, primarily related to blood flow in the heart & blood vessels, brain, respiratory system and human joint system.

CO3: Analyze the specific pathological conditions in human body related to fluid dynamics.

CO4: Solve the problems associated with real-life biological flow applying engineering concepts of fluid mechanics.

CO5: Determine the flow behaviour & parameters in circulatory and respiratory flow system.

Course Content:

Module- 1: Properties of Fluids 5L

Fluid properties, classification and applications, concept of viscosity, compressibility and Elasticity, Surface tension and capillarity. Newton's law of viscosity, dynamic viscosity, kinematic viscosity, variation of viscosity with temperature, Surface tension and capillarity. Concept of Newtonian and Non-Newtonian Fluids.

Module- 2: Fluid Flow and Boundary Layer 7L

Basic laws of fluid dynamics – conservation of mass, conservation of linear momentum, conservation of energy, Reynolds number, Ideal fluid flow, Real fluid flow- Laminar and turbulent flow, Laminar Flow of Non-Newtonian Fluids, Transition from laminar to turbulent flow, measurement of viscosity, Application of Bernoulli's equation, Fundamentals of Boundary layer, Velocity profile, Losses in pipes.

Module- 3: Blood Rheology and Flow Dynamics in Blood Vessels 11L

Physical, Chemical and Rheological properties of blood, Effect of shear rate, Haematocrit, Temperature, Protein content on blood viscosity, Relationship between diameter, velocity and Pressure of blood flow (Hagen-Poiseuille equation), Flow properties of blood through the blood vessels- steady flow and pulsatile flow, Wave propagation in elastic tubes, Forces that drive or resist blood flow, Diseases related to obstruction of blood flow, Friction loss in flow in a tube, velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries. Casson's Equation, Problems associated with extracorporeal blood flow.

Module- 4: Cardiac and Respiratory Flow Mechanics 5L

Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins, Physics of cardiovascular diseases, Fundamentals of fluid structure interaction. Prosthetic heart valves and replacements.

Respiratory system physiology. Alveolar ventilation. Air flow in the lungs. Mechanics of breathing. Gas exchange and transport.

Module- 5: Synovial Fluid Mechanics in Joints 5L

Synovial joints physiology, Function of synovial fluid, Diseases, Synovial fluid properties and rheology, Lubrication theory, Different types of lubrication in human joints, Application for synovial fluid flow, Arthritis, Knee and Hip injury.

Module- 6: Bio-fluid Dynamics in Human Brain 3L

Cerebrospinal fluid. Cerebral blood flow. Blood brain barrier, Brain diseases.

Text Books:

1. Introduction to Fluid Mechanics-James E.A. John and William L. Haberman, 2nd Edn, Prentice Hall, INC.
2. Y.C Fung, Biomechanics- Mechanical properties of living tissues, 2nd Edn, Springer Verlag, 1993.
3. D.O Cooney, Biomedical engineering Principles. Marcel Dekker, INC New York. 1976.
4. C. Ross Ethier and Craigg A. Simmons, Introductory Biomechanics, Cambridge texts in Biomedical Engineering, 2007.
5. C. Kleinstreuer, Biofluid Dynamics: Principles and Applications, CRC Press, TaylorandFrancis Group, 2006.
6. L. Waite, Applied Biofluid Mechanics, McGraw Hill, 2007.

Reference Books:

1. Biomechanics by Nihat ozkaya and Margareta Nordin
2. D.A Mc Donald, Blood flow in arteries, Edward Arnold ltd, 1998.
3. J. N. Mazumdar, Biofluid Mechanics, World Scientific, 2004.
4. L. Waite, Biofluid Mechanics in Cardiovascular Systems, McGraw-Hill, 2006.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	2	-	-	2	2	-	-	2
CO5	3	3	-	-	-	-	-	-	2	-	-	2
Avg.	3	3	3	-	2	-	-	2	2	-	-	2

COURSE NAME: BIOPHYSICAL SIGNALS AND SYSTEMS
COURSE CODE: BME403
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Knowledge of Integration, Differentiation, Complex Numbers.

Course Outcomes:

At the end of the course, student should be able to:

CO1: Determine the mathematical concept and transformation of Continuous Time and Discrete Time Signals and various systems emphasizing on Linear Time Invariant System.

CO2: Analyze various signals in Fourier and Z domain and the need of Laplace Transform.

CO3: Categorize various forms and types of Filters and its mathematical design & formulation.

CO4: Apply the concept and mathematical principles of signals and systems in Biophysical domain.

Course Content:

Module- 1: Signals and systems **7L**

Continuous time (CT) signals, Discrete time (DT) signals, periodic, aperiodic, random, energy and power signals, energy and power of a signal, absolutely integrable signals, step, ramp, impulse and exponential function, mathematical relation between Step, Ramp and Impulse functions, properties of Impulse function, Transformation in independent variable of signals: time scaling, time shifting and time reversal, Introduction to systems and its properties, LTI systems, Convolution and its properties: Linear operation.

Module- 2: Signal analysis **6L**

Basic concepts of the Fourier series, Dirichlet Conditions, and Properties of continuous and discrete time Fourier series, Discrete Fourier transform (DFT) and its inverse (IDFT), Properties of Fourier Transform. Fast Fourier transformation (FFT): Decimation in time algorithm.

Module- 3: Sampling Theorem, Laplace Transforms and Z-Transforms **8L**

Representation of continuous time signals by its sample, Sampling theorem, Reconstruction of a Signal from its samples, aliasing, Nyquist criterion. Laplace transform: basics, properties, use of

ROC and its basic properties, identification of the stability of system and absolutely integrable signals from ROC, inverse; z-transform: definition, properties, Poles and Zeros, inverse z-transform; Region of convergence (ROC), Representation of systems by differential equations and transfer functions.

Module- 4: Noise, Feedback and Control System **5L**

Noise: Sources and Types, Basic Feedback concept, Positive and Negative Feedback, Control system, Open and Closed loop Control System, Control system With Feed Back, Application of feedback in physiological systems and its importance: Muscle Stretch Reflex. System Physiology

versus Systems Biology.

Module- 5: Filtering Techniques **4L**

Basic concepts of IIR and FIR filters, difference equations, Realization of Filters using Direct form –I, II and Cascade Form, Design of IIR Filter using impulse invariant and bilinear transforms.

Module- 6: Application in Physiological System **6L**

Block diagram representation of cardio vascular system, Electrical analog of blood vessels and its transfer function, Electrical Analogue of Arterial Blood Pressure Signals: 3 elements Wind kessel Model, Characteristics of various bio-signals (ECG, EEG, EMG etc,) signal conditioning and noise handling.

Text Books:

1. P. Ramesh Babu , Digital Signal Processing, Scitech Publications (India) Pvt Ltd
2. John Proakis, Dimitris Manolakis, Digital Signal Processing, Pearson

Reference Books:

1. Gayakward - Opamps and Linear Integrated Circuits, Prentice Hall India
2. A. K. Sawhney -Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. (P) Ltd

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	-	3
Avg.	3	2.5	2	-	2	-	-	-	-	-	-	3

COURSE NAME: MEDICAL PHYSICS
COURSE CODE: PH(BME)401
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 2

Prerequisite: Knowledge of Engineering Physics upto B.Tech 1st year.

Course Outcome
After completion of this course student will be able to

CO1: Explain the working principle of various types of microscopes, imaging and radioactive systems.

CO2: Apply the display and detection devices in bio-detection.

CO3: Analyze the physics of various kinds of electric, magnetic, superconducting and radioactive materials.

CO4: Justify the importance of electric and magnetic materials in biomedical engineering.

Course Content:

Module 1: Electric and Magnetic properties of materials 12L

Module 1.01: Insulating materials 5L

Dielectric Material: Concept of Polarization, relation between **D, E** and **P**, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), behavior of Dielectric under alternating field (qualitative discussion only),Dielectric losses, Local electric field at an atom: Lorentz field, Lorentz relation; Dielectric constant and polarizability – Clausius-Mossotti equation (with derivation) ;. ferroelctric and piezoelectrics (Qualitative study).

Module 1.02: Magnetic materials and storage devices 5L

Magnetic Field & Magnetization M, relation between **B, H, M**. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of θ_p, Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.)

Module 1.03: Super conductivity 2L

Basic concept, qualitative study up to Meissner effect, examples of High Temperature Superconductor, BCS theory (qualitative), Applications in Biomedical Engineering.

Module 2: Display, Nuclear Medicine, Medical Imaging devices 12L

2.01: Display 3L

Operation and application of CRT (AC), Physics of Liquid crystal display (LCD), LED

2.02: Radiation therapy **2L**

Radio activity, doses, strength, applications.

2.03: Medical detection and Imaging devices **7L**

X-ray, CT, PET, PET-CT, Nuclear Magnetic Resonance (NMR), Magnetic resonance imaging (MRI), Principle of Electro cardiogram (ECG) and electroencephalogram(EEG), Principle of Auto-refractor.

Text / Reference Books

1. Insulating Materials: Principles, Materials, Applications, Margit Pfundstein , Roland Gellert , Martin Spitzner & Alexander Rudolphi: Birkhauser Verlag AG; 1
2. High Voltage and Electrical Insulation Engineering, Ravindra Arora, Wolfgang Mosch: Online ISBN:9780470947906 DOI: 10.1002/9780470947906 Series Editor(s): Mohamed E. El-Hawary
3. Physics-II, Sujay Kumar Bhattacharya and Soumen Pal, McGraw Hill Education Private Limited
4. Advanced Engineering Physics, S. P. Kuila, New Central Book Agency (P) Ltd
5. Principles of Engineering Physics Vol 1 and Vol 2; by Md. N. Khan and S. Panigrahi, Pub: Cambridge Univ. press
6. Fundamental of Statistical and Thermal Physics: .F. Reif Advanced Engineering Physics-S. P. Kuila New Central Book Agency (P)Ltd.
7. Electricity and Magnetism (In Si Units): Berkeley Physics Course - Vol.2, Edward M Purcell Introduction to Electrodynamics-Griffiths David J.
8. Solid State Physics, A. J. Dekker, McMillan
9. Nuclear Physics, Irvin Keplan
10. Nuclear Physics, J. Pearson, University of Manchester, 2008
11. Nuclear and Particle Physics, Jenny Thomas - University College London ,2000.
12. Solid State Physics, S.O. Pillai.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	2	3	-	-	-	-	-	-	-	-	-	2
CO4	2	2	2	3	-	-	-	-	-	-	-	2
Avg.	2.5	2	2	3	-	-	-	-	-	-	-	2

COURSE NAME: DIGITAL ELECTRONICS AND DEVICES
COURSE CODE: EC(BME)402
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, Basic Electronics Engineering

Course Outcomes:

After completion of this course, students will be able to

CO1: Determine the concept of different sub-components of Electronics Circuits.

CO2: Apply the knowledge of mathematics, science and engineering fundamentals to solve related numerical.

CO3: Perform logical analysis of result/systems of different types of Electronics Circuits.

CO4: Design different networks using digital circuits.

Course Content:

Module- 1: Number systems and Computer codes 4L

Binary, Octal, Decimal and Hexadecimal representation and their conversions; Signed binary number representation and operations with 1's and 2's complement methods; BCD, Gray codes, ASCII, EBDIC.

Module- 2: Basic Logic Gates and Logic Families 4L

Various Logic gates- their truth tables and circuits; Introduction to different logic families, TTL, MOS and CMOS logic gates, working principles, relative merits and demerits.

Module- 3: Boolean Switching algebra and Minimization technique 4L

Basics of Boolean Algebra and its various laws, Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, K-map method.

Module- 4: Combinational Logic Circuits and Arithmetic Logic Circuits 8L

Adder (Full and Half), Subtractor (Full and Half), Encoder and its various types, Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator.

Programming logic devices and gate arrays (PLAs, PLDs, FPGA).

Module- 5: Sequential Logic Circuits 12L

Basic memory element: Latches: Active High and Active Low Latches.

Flip Flops: S-R, J-K, D and T Flip Flops, Race Around Condition of JK Flip Flops, Master and Slave JK Flip Flops, Registers: Types, Counters: Types, Johnson Counter, Ring Counter, State table and state transition diagram, Sequential circuits design methodology.

Module- 6: Memories and Data Converter 4L

Basics of RAM, ROM, EPROM, EEROM, AD Converter, DA Converter.

Text Books:

1. Sedra and Smith-Microelectronic Circuits- Oxford UP
2. Boylested and Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
3. S. Salivahanan, S. Aribazhagan, Digital Circuit and Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
4. Anand Kumar, Fundamentals of Digital Circuits- PHI
5. Kharate- Digital Electronics- Oxford

Reference Books:

1. Millman and Halkias – Integrated Electronics, McGraw Hill.
2. Rashid-Microelectronic Circuits-Analysis and Design- Thomson (Cenage Learning)
3. Malvino—Electronic Principles, 6/e, McGraw Hill
4. Morries Mano- Digital Logic Design- PHI
5. Leach and Malvino—Digital Principles and Application, 5/e, McGraw Hill
6. H. Taub and D. Shilling, Digital Integrated Electronics- McGraw Hill.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**3**
Avg.	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**3**

COURSE NAME: BIOMATERIALS LAB
COURSE CODE: BME491
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of materials including physical, chemical and mechanical properties of different materials.

Course Outcomes:

After completion of this course, students will be able to

CO1: Determine the mechanical properties of biomaterials using destructive and non-destructive testing.

CO2: Measure the Surface roughness of biomaterials as per the ASTM standards.

CO3: Perform *invitro* hemocompatibility study for implantable biomaterials.

CO4: Conduct the experiment to measure the pH, Viscosity, and Conductivity of the body fluid.

List of Experiments:

1. Mechanical Characterization of Biomaterials
2. Hardness Testing of Metallic Biomaterials
3. Hardness Testing of Polymeric Biomaterials
4. Surface Roughness measurement
5. *Invitro* hemocompatibility study of biomaterials
6. pH measurement of Body Fluid
7. Conductivity Measurement of Body Fluid
8. Viscosity Measurement of Body Fluid
9. Non-Destructive Testing of Biomaterials
10. Innovative Experiment

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	3	-	-	-	2	-	-	3
CO2	3	-	-	2	3	-	-	-	-	-	-	-
CO3	3	3	2	2	3	-	-	3	2	2	-	2
CO4	3	3	2	2	3	-	-	3	2	2	-	2
Avg.	3	3	2	2	3	-	-	3	2	2	-	2

COURSE NAME: BIOMECHANICS LAB
COURSE CODE: BME492
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of mechanics including kinetics and kinematics and human functional anatomy.

Course Outcomes:

After completion of this course, students will be able to

CO1: Illustrate linear and angular descriptors of human motion (kinematics) and quantify the forces associated with human movement (kinetics).

CO2: Analyze the mechanical characteristics of Hip prosthesis using stress strain diagram.

CO3: Calculate the Gait variables related with body movement using biomechanical principles.

CO4: Design and perform tapping torque tests (TTT) according to the ASTM standard.

List of Experiments:

1. Determination of Moment of Inertia using Compound Pendulum method
2. Determination of Moment of Inertia using dynamometer
3. Stress strain analysis of Hip Prosthesis
4. Measurement of Gait variables
5. Foot Pressure measurement
6. Joint angle measurement
7. Grip Force Measurement
8. Tapping Torque Measurement
9. Innovative Experiment

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	2	-	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	2	-	-	-
CO3	3	3	-	2	-	-	-	-	2	-	-	2
CO4	3	3	3	-	2	-	2	-	2	-	2	2
Avg.	3	3	3	2	2	-	2	-	2	-	2	2

COURSE NAME: BIOPHYSICAL SIGNALS AND SYSTEMS LAB
COURSE CODE: BME493
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Engineering Mathematics and Basics of Vector theory and MATLAB.

Course Outcomes:

At the end of the course, student should be able to

CO1: Determine various signals and systems using MATLAB.

CO2: Perform Fourier series, Fourier transform and Laplace Transform for different signals using MATLAB.

CO3: Analyze the Continuous Time systems by performing Convolution using MATLAB

CO4: Measure Discrete-time systems and LTI systems using Z-transforms using MATLAB.

List of Experiments:

1. Familiarization with MATLAB and generation of various types of waveforms (sine, cosine, square, triangular etc.).
2. Generation of different functions (unit impulse, unit step, RAMP, etc.)
3. Generation of various types of Convolutions (Linear and Circular).
4. To study Z- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
5. To study Laplace- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
6. To study Fourier- transform using MATLAB.
7. To study CTFT and DTFT
8. To study LPF and HPF, band-pass and reject filters using RC circuits
9. Innovative experiments

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	-	-	2	-	-	3
CO2	3	2	2	2	2	-	-	-	2	-	-	3
CO3	3	2	2	2	2	-	-	-	2	-	-	3
CO4	3	2	2		2	-	-	-	2	-	-	3
Avg.	3	2	2	2	2	-	-	-	2	-	-	3

COURSE NAME: DIGITAL ELECTRONICS AND DEVICES LAB
COURSE CODE: EC(BME)492
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Basic Electronics Engineering

Course Outcomes:

After the course, students will be able to

CO1: Illustrate the concept of Digital Electronics Circuits with its functional components.

CO2: Apply the knowledge of mathematics, science and engineering fundamentals to solve the related problems.

CO3: Perform logical analysis of result/systems of related Circuits.

CO4: Design different networks using digital circuits.

List of Experiments:

1. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR and Realization of basic gates using universal logic gates.
2. Gray Code to Binary Code Conversion and Vice Versa.
3. Construction of simple arithmetic circuits- Adder, Subtractor.
4. Construction of simple Decoder and Multiplexer circuits using logic gates.
5. Construction of Four-bit parity generator and comparator circuits.
6. Realization of R-S, J-K and D flip-flops using Universal logic gates.
7. Realization of Counter Circuits
8. Innovative experiments

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	3	-	-	-	-	-	3
CO2	3	3	1	-	2	1	-	-	-	-	-	3
CO3	3	2	2	2	-	3	-	-	-	-	-	3
CO4	3	-	1	-	2	3	-	-	-	-	-	3
Avg.	3	2.5	2	1.5	2	2.5	-	-	-	-	-	3

3rd Year 5th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	BME501	Biomedical Instrumentation	3	0	0	3	3
2	ENGG	Major	BME502	Biosensors and Transducers	3	0	0	3	3
3	ENGG	Major	BME503	Medical Imaging Systems - I	3	0	0	3	3
4	ENGG	Major	BME504A	Communication Systems and Biotelemetry	3	0	0	3	3
			BME504B	Bioelectrical and Bioelectronics Measurement					
			BME504C	Biomedical Informatics					
5	ENGG	Minor	CS(BME)505A	Data Structure and Algorithm	3	0	0	3	3
			EC(BME)505B	VLSI and Embedded System					
			EE(BME)505C	Measurement and Control System					
B. Practical									
1	ENGG.	Major	BME591	Biomedical Instrumentation Lab	0	0	2	2	1
2	ENGG.	Major	BME592	Biosensors and Transducers Lab	0	0	2	2	1
3	ENGG	Minor	CS(BME)595A	Data Structure and Algorithm Lab	0	0	2	2	1
			EC(BME)595B	VLSI and Embedded System Lab					
			EE(BME)595C	Measurement and Control System Lab					
4	HUM	Ability Enhancement Course	HU591	Skill Development - IV: Analytical and Logical Thinking Skills - II	0	0	2	2	1
5	PRJ	Project	BME581	Minor Project - I	0	0	2	2	1
Total of Theory and Practical Courses								**25**	**20**

A. Theory

COURSE NAME: BIOMEDICAL INSTRUMENTATION
COURSE CODE: BME501
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Analog and Digital electronics

Course Outcomes:

After completion of this course students will be able to

CO1: Categorize the origin of bio-potentials and inspect common bio-signals by their features.

CO2: Interpret the features and operations of basic to advanced medical instrumentation system its necessity in healthcare system.

CO3: Analyze the characteristics and performance requirements of medical instrumentation and data acquisition system.

CO4: Apply the knowledge to design bio-potential amplifiers, various medical recording systems and patient monitoring systems.

Course Content:

Module- 1: Medical Instrumentation **6L**

Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors and Computers in medical instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.

Module- 2: Measurement Systems **6L**

Specifications of instruments, Static and Dynamic characteristics of medical instruments, Classification of errors, Statistical analysis, Reliability, Accuracy, Fidelity, Speed of response, Linearization of technique, Data Acquisition System.

Module- 3: Bioelectric Signals and Bioelectric Amplifiers **8L**

Origin of bioelectricsignals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Instrumentation amplifiers, Special features of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector

Module- 4: Biomedical Recording Systems **10L**

Basic Recording systems, General consideration for signal conditioners, Preamplifiers, Differentia l Amplifier, Isolation Amplifier, Electro cardiograph, Phonocardiograph, Electro encephalograph, Electromyography, Digital stethoscope Other biomedical recorders, Biofeedback instrumentation, Electrostatic and Electromagnetic coupling to AC signals, Proper grounding, Patient isolation and accident prevention.

Module- 5: Patient Monitoring Systems **6L**

System concepts, Selection of system parameters, Cardiac monitor, Bedside monitors, Central monitors, Heartrate meter, Pulse rate meter, Measurement of respiration rate, Holter monitor and Cardiac stress test, Catheterization Laboratory Instrumentation, Organization and Equipment used

in ICCU and ITU.

Text Books:

1. R.S. Khandpur "Handbook of Bio-Medical Instrumentation",2nd Edition, Tata McGraw Hill.
2. J.J. Carr and J.M. Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall, India

Reference Books:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg., Boston. J. Webster, "Bioinstrumentation", Wileyand Sons.
2. Joseph D. Bronzino, "The Biomedical Engineering handbook", CRC Press.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**2**	**-**		**-**	**-**	**-**	**-**	
CO3	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
Avg.	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: BIOSENSORS AND TRANSDUCERS
COURSE CODE: BME502
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of sensors and transducers and fundamentals of instrumentation.

Course Outcomes:

After completion of this course students will be able to

CO1: Illustrate the transduction principle, classifications, characteristics of different transducers and its biomedical applications.

CO2: Correlate the concepts, types, working mechanism and practical applications of important electrodes for acquiring and recording various physiological parameters.

CO3: Apply the basic principles of bio-sensing in terms of biological, chemical, and optical/photonic responses.

CO4: Categorize the different biological sensors and compare different techniques with sensitivity & selectivity and critically evaluate a selected application of a biosensor.

CO5: Determine the bioelectrical signals and physiological variables using biosensors and bioelectrodes.

Course Content:

Module- 1: Transducer's Principles and Medical Applications 10L

Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, p-n junction, chemical thermometry, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer:variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo-emissive tubes, photovoltaic cell, photoconductive cell, photodiodes, Flow transducers: magnetic, resistive and ultrasonic.

Module- 2: Bio-potential Electrodes 6L

Electrode theory, Electrode electrolyte interface, polarizable and non-polarizable electrodes, Electrode behavior and Circuit models, Electrode-skin Interface and Motion Artifact, Skin surface recording Electrodes, Microelectrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal microelectrodes, micropipette (metal filled glass and glass micropipette electrodes), properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (for ECG, EMG & EEG).

Module- 3: Biosensors 6L

Definition, various components of biosensors, types of biosensors, Bio-catalysis based biosensors, Bio-affinity based biosensors and Microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions, Various recognition, Techniques, Recognition event: Catalytic, Single and multiple enzymes, Bio Affinity: Labeled and Label free,

whole cellsensing – bacteria, yeast, mammalian cell, Generation of Biosensor; Biomolecule Immobilization techniques, Enzyme Kinetics Advantages and limitations.

Module- 4: Chemical Biosensors 6L

Electrochemical sensors for ions and dissolved gases measurement, Reference electrodes - Hydrogen electrodes - silver-silver chloride electrodes- Calomel electrodes. Measurement of pH-Glass pH electrodes. Measurement of pO2, Measurement of pCO2 -catheter tip electrodes for the measurement of pO2 and pCO2, conductivity measurement transducer, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors. Transcuteneous arterial oxygen tension and carbon dioxide tension monitoring enzyme electrode.

Module- 5: Optical Sensor and Radiation Detectors 4L

Principles of optical sensors, optical fiber sensors, indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionization chamber, Geiger counters, Scintillation detectors.

Module- 6: Biological sensors 4L

Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immune-sensors, Basic principles of MOSFET biosensors and BIOMEMS, basic idea about Smart sensors.

Text Books:

1. S.C. Cobbold, “Transducers for Biomedical Instruments”, Prentice Hall.
2. Rao and Guha, Principles of Medical Electronics and Biomedical Instrumentation, University Press, India.
3. Carrand Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

Reference Books:

1. A.V.S. De Renck , “Touch Heat and Pain”, Churchill Ltd. London.
2. Harry Thomas, “Handbook of Bio Medical Instrumentation”, Reston, Virginia.
3. L. Wise, “Applied Bio Sensors”, Butterworth, London.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	3	-	-	2	2	-	-	2
Avg.	3	3	-	-	3	-	-	2	2	-	-	2

COURSE NAME: MEDICAL IMAGING SYSTEMS - I
COURSE CODE: BME503
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Physics and Medical Instruments.

Course Outcomes:

After completion of this course students will be able to

CO1: Determine the physics and principles behind the operations of different medical imaging equipment under different modalities.

CO2: Illustrate the radiation effects on biological tissues and implement efficient radiation safety protocols in the operations of wide spectrum of imaging methods.

CO3: Analyze the operation and architecture of different types of imaging equipment.

CO4: Interpret the most effective imaging modality for a particular organ.

Course Content:

Module- 1: X-Ray Machines and X-Ray Image Formation 16L

Physics and production of X-Rays, Stationary and Rotating Anode tube, Tube Enclosure, Tube Rating Charts, Conventional Electrical Circuit ofX-Ray Machine, Conventional and High Frequency Generators, Control Circuits-HV control, Filament Control, Tube Current, Exposure Timing, Automatic Exposure Control, Accessories of X-Ray. Stationary X-Ray Unit, Mobile X-Ray and Portable Units.

Specialized X-Ray Machine - Mammographic X-Ray Machines, Dental X-Ray Machines.

X-Ray Film, Cassettes, Film Sensitometry, Radiographic Film Image Formation. Dark Room Accessories- Developer and Fixer. Image Quality Factors, CR, Image Intensifiers, DR, Safety Protocols and Doses, Dose Equivalent and REM.

Module- 2: Computed Tomography 10L

Principles of Computed Tomography, Scanning Systems, Detectors in CT, Data Acquisition System and Processing, Storing and Viewing System, Gantry Geometry, Different Information from Gantry, Hounsfield Numbers, Image Reconstruction Techniques: Back Projections, Iterative and analytical methods, Image quality and Artifacts, Dose in CT, Spiral CT. Introduction to DICOM and PACS.

Module- 3: Ultrasound Imaging 10L

Physics of ultrasound and Production of ultrasound, medical ultrasound, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe structure, probe types, beam steering, Principles of image formation, capture and display- Principles of A Mode, B Mode and M Mode. Types of US Imaging, Real- time ultrasonic imaging systems, electronic scanners, Doppler ultrasound and Colour velocity mapping, duplex ultra sound, image artifacts, bio-effects and safety levels.

Text Books:

1. Carr and Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
2. R.S. Khandpur, “Handbook of Bio-Medical Instrumentation”, Tata McGraw Hill.
3. J. Webster, “Bioinstrumentation”, Wiley and Sons

Reference Books:

1. Dowsett, Kenny and Johnston, “The Physics of Diagnostic Imaging”, Chapman and Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford and Hose, “Medical Physics and Biomedical Engineering”, Institute of Physics Publishing, Bristol.
3. Massey and Meredith, “Fundamental Physics of Radiology”, John Wright and Sons.
4. S. Webb, “The Physics of Medical Imaging”, Adam Hilger, Bristol.

CO–PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**3**
CO3	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**
Avg.	**3**	**2**	**-**	**2**	**-**	**3**	**-**	**2.5**	**-**	**-**	**-**	**2.5**

COURSE NAME: COMMUNICATION SYSTEMS AND BIOTELEMETRY
COURSE CODE: BME504A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, Digital Electronics, Signal Theory.

Course outcomes:

After completion of the course students will be able to

CO1: Determine the different methods of modulation (both analog and digital).

CO2: Analyze data communication-oriented problems and solve them in biomedical communication.

CO3: Apply modern communication systems in telemedicine.

CO4: Identify the problems in communication systems.

Course Content:

Module- 1: Analog and Digital Communication 12L

Introduction to Communication Systems, Modulation: Types; Need for Modulation; Theory of Amplitude Modulation: Basic idea, Modulation and Demodulation; Frequency Modulation: Basic idea, Modulation and Demodulation

Pulse Communication: Sampling Theorem, Pulse Amplitude Modulation (PAM): Basic idea, Modulation and Demodulation. Basic concepts of digital modulation, Pulse code Modulation (PCM): Sampling, Quantization, Companding, Coding; Amplitude Shift Keying (ASK): Basic idea, Modulation and Demodulation; Frequency Shift Keying (FSK): Basic idea, Modulation and Demodulation

Module- 2: Data Communication 8L

Data Communication: OSI Model – Basic working principle of each layer, LAN, WAN; Modem – Working Principle, Speed calculation; Switch and Router – Working Principle; Cryptography – Basic idea

Error Detection and Correction –Hamming code, cyclic code

Module- 3: Biotelemetry 8L

Bio-Telemetry System: Components of telemetry system, bio-telemetry and its importance, single and multi-channel biotelemetry, ECG telemetry system, temperature telemetry system, telemetry of ECG and respiration, sports telemetry, multi-patient telemetry, ambulatory patient monitoring, implantable telemetry systems, transmission of physiological signals over telephone line, telemedicine and applications.

Module- 4: Modern Communication System 8L

Introduction, Principles of Video Conferencing, Telemedicine, Mobile communication – GSM Architecture and working principle; Bluetooth; WLAN

Text Books:

1. B. P. Lathi, “Modern Analog and Digital Communication Systems”, 3rd Edition, Oxford University Press.
2. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley and Sons.
3. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education.
4. R.S. Khandpur; “Handbook of Bio-Medical Instrumentation”, 2nd Ed.; TMH

Reference Books:

1. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education.
2. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education.
3. Blake, “Electronic Communication Systems”, Thomson Delmar Publications.
4. Martin S.Roden, “Analog and Digital Communication System”, 3rd Edition, Prentice Hall of India.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	2	-	-	-	-	-	-	-
CO3	3	3	-	-	-	2	-	-	-	-	-	2
CO4	3	3	3	-	-	-	-	-	-	-	-	-
Avg.	3	3	3	-	2	2	-	-	-	-	-	2

COURSE NAME: BIOELECTRICAL AND BIOELECTRONICS MEASUREMENT
COURSE CODE: BME504B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of electrophysiology, Bio-transducers and Bioinstrumentation.

Course Outcomes:

After completion of this course student will be able to

CO1: Determine the origin and propagation of bioelectric potentials and their characteristics.

CO2: Estimate the bio-potentials developed using different types of electrodes and technique.

CO3: Apply the knowledge of electronics in the measurement of bio-signals.

CO4: Implement the concept of electronics in the development of prosthetic devices and patient monitoring system.

Course Content:

Module- 1: Introduction to Bioelectric Potentials 6L

Introduction to Physiological systems of the body, Sources of Bioelectric potentials, Propagation of action potential, Bioelectric potentials ECG, EEG and EMG responses, Spectral characteristic of bio-signals, Development of Bioelectric potential measurement, Problems encountered in measuring a living system.

Module- 2: Transport Processes 6L

Basic concepts of transport processes, Propagation of electrical impulse through ion exchange, Chemical balances, force balances, general bioelectrical potential balances, Kirchhoff's laws, Conservation of mass and energy.

Module- 3: Measurement of Bioelectrical Phenomenon 10L

Generation of ECG, Electrocardiography, Measurement of heart rate and cardiac output, Cardiac Abnormality Diagnosis by ECG. Nerve impulse transmission through Spinal cord, Characteristics of Electroencephalogram (EEG), Techniques of Measurement of EEG. Generation of Muscle Action Potential, Motor movement analysis, Physiology of Electromyogram (EMG), Measurement Techniques of Electromyography.

Module- 4: Overview of Bioelectronics 8L

Interactions between electronics and biomedical science; fundamental properties of ions in the solution; electrical properties of cellular components: lipid bilayer and membrane proteins; Natural nano-conductors: ion channels and pumps; Single channel recording: the measurement and the noise; Patch clamp amplifier -the electronics of low noise current detection.

Module- 5: Bioelectronics in Prosthetic Devices and Patient Monitoring 6L

Brain-computer interface, Neural implants, Retinal Implants, Bionic arm, Cochlear implants/ Bionic ear, - lung machine, Nerve – muscle stimulator, Requirement of Continuous Monitoring of

Bioelectrical Signals, Elements of intensive care monitoring, Patient monitoring displays, Multi-parameter Monitoring Device, Automated Diagnosis of Bioelectrical Signals.

Text Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. Rao and Guha, "Principles of Medical Electronics and Biomedical Instrumentation", University Press, India.
3. Ions, electrodes and membranes. By J. Koryta, John Wiley and Sons, New York, 2nd edition, 1992,
4. Carrand Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

Reference Books:

1. Iberall and Guyton, Regulation and Control in Physiological System, Instruments Soc.USA.
2. Harry Thomas, "Handbook of Biomedical Instrumentation", Reston, Virginia.
3. S.C. Cobbold, "Transducers for Biomedical Instruments", Prentice Hall.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	2	2	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	3	2	1	3
Avg.	3	2.7	-	2	3	-	-	-	2.5	2	1	3

COURSE NAME: BIOMEDICAL INFORMATICS
COURSE CODE: BME504C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Concept of Biological Science, Mathematics, Statistics, Organic Chemistry, Computational theory, Analysis and Algorithm Design.

Course Outcomes:

At the end of the course, the student will be able to

CO1: Identify the bioinformatics database, cellular interaction and process**.**

CO2: Apply bioinformatics and biological database to solve real life problems.

CO3: Analyze diversified bioinformatics tools for processing data, performing text or sequence-based search.

CO4: Illustrate the impact of bioinformatics in a global, economic, environmental, and societal context.

Course Content:

Module- 1: Introduction to Cellular Biology 6L

Concepts of Cell, types of cells, components of cell, organelle. Functions of different organelles. Basic Structure of DNA; Double Helix structure, Watson and Crick model. Exons and Introns and Gene Concept. Basic structure, Difference between RNA and DNA. Types of RNA. Basic components and structure. Transcription and Translation; Introduction to Metabolic Pathways.

Module- 2: Introduction to Bioinformatics and Search Engines 8L

Recent challenges in Bioinformatics. Data Warehouse, Data models, Database Management Concepts. Different Bioinformatics database types. Protein Sequence Databases: PDB, SWISS-PROT database.

DNA sequence data bases: DDBJ, Gen bank.

Sequence database search program slike BLAST and FASTA. NCBI different modules: Gen Bank; OMIM, Taxonomy browser, Pub-Med.

Module- 3: DNA Sequence Analysis 12L

DNA Mapping and Assembly: Size of Human DNA, Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Short DNA Molecules, Mapping Long DNA Molecules. DeBruijn Graph. Sequence Alignment: Introduction, local and global alignment, pairwise and multiple alignments, Dynamic Programming Concept. Alignment algorithms: Needleman and Wunsch algorithm, Smith-Waterman.

Module- 4: Introduction Probabilistic Models Used In Computational Biology 10L

Probabilistic Models; Hidden Markov Model: Concepts, Architecture, Transition matrix, estimation matrix. Application of HMM in Bioinformatics: Gene finding, profile searches, multiple sequence alignment and regulatory site identification. Bayesian networks Model: Architecture, Principle, Applications in Bioinformatics.

Biological Data Classification and Clustering

Assigning protein function and predicting splice sites: Decision Tree

Text/Reference Books:

1. Bioinformatics and Molecular Evolution by Paul G. Higgs and Teresa K. Attwood
2. Bioinformatics Computing by Bryan Bergeron
3. Bioinformatics and Functional Genomics by Jonathan Pevsner
4. Gene Cloning and DNA Analysis by T.A. BROWN

CO– PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	-
CO2	2	2	2	3	3	1	1	-	-	-	-	-
CO3	2	3	3	3	3	2	2	-	-	-	-	2
CO4	1	1	-	-	-	2	3	-	-	-	-	1
Avg.	1.75	2	2.67	3	3	1.67	2	-	-	-	-	1.5

COURSE NAME: DATA STRUCTURE AND ALGORITHM
COURSE CODE: CS(BME)505A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Mathematics, Programming language

Course Outcomes:

After completion of this course student will be able to

CO1: Use different kinds of data structures which are suited to different kinds of applications, and some are highly specialized to specific tasks.

CO2: Manage large amounts of data efficiently, such as large databases and internet indexing services.

CO3: Use efficient data structures which are a key to designing efficient algorithms.

CO4: Store and retrieve data stored in both main memory and in secondary memory.

Course Content:

Module- 1: Introduction 8L

Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. Array: Different representations – row major, column major. Array representation of polynomials. Linked List: Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Module- 2: Stack and Queue 6L

Stack and its implementations (using array, using linked list), applications. Queue, circular queue, de-queue. Implementation of queue- both linear and circular (using array, using linked list), applications. Recursion: Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi.

Module- 3: Trees 12L

Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only).

Module- 4: Sorting Algorithms and Searching 10L

Sorting Algorithms: Internal sorting and external sorting Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap), radix sort.
Searching: Sequential search, binary search, Hashing: Hashing functions, collision resolution techniques

Text Books:

1. Data Structures Using C, by Reema Thereja, OXFORD Publications
2. Data Structures and Algorithms Using C by Amitava Nag and Joyti Prakash Singh, VIKASH Publication
3. Data Structures by S. Lipschutz.

Reference Books:

1. Data Structures Using C, by E. Balagurusamy E. Mc graw Hill)
2. Data Structures Using C and C++, by Moshe J. Augenstein, Aaron M. Tenenbaum

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Avg.	**3**	**2.67**	**2.5**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: VLSI AND EMBEDDED SYSTEM
COURSE CODE: EC(BME)505B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic concept of courses Solid State Devices, Analog Electronic Circuits, Digital Electronic and Circuits

Course Outcomes:

After this course students will be able to

CO1: Describe scale of integration – SSI, MSI, LSI, VLSI, Moor's Law, scaling, short channel effect, VLSI design flow, FPGA architecture and construct gate level circuit with PAL and PLA concept

CO2: Analyze CMOS inverter voltage transfer characteristics with the parameters – VIL, VIH, VOL, VOH, Vth and based on the knowledge of digital circuit design methodology like – CMOS, Pass transistor, TG, dynamic logic, NORA, and also construct schematic of combinational, sequential circuit, SRAM, DRAM cell using MOSFET

CO3: Calculate value of resistance of current source, MOS diode, current of current mirror circuit, voltage of references (voltage divider, threshold voltage and band gap), value of parameters to design CMOS differential amplifier and two stage OP-AMP, emulate resistance of switch capacitor circuit

CO4: Design different microcontroller-based circuits and complex real time applications

CO5: Interface different sensors, actuators, and communication devices with the microcontrollers and perform complex real-life projects

Course Content:

Module 1: Introduction to IC **5L**

Integrated Circuits – Advantages, disadvantages, limitations; Scale of Integration – SSI, MSI, LSI, VLSI, ULSI; Moor's Law; Scaling of MOSFET-Constant field scaling and constant voltage scaling, Short Channel Effects; VLSI design flow, Y-Chart, IC Classification –Standard IC and ASIC, PAL, PLA.

Module 2: Digital VLSI Circuit Design **10L**

Inverter Characteristics **2L**

Resistive load inverter – Voltage transfer characteristics (VTC, significance of parameters (only expression, no derivation) –VIL, VIH, VOL, VOH, Vth; CMOS inverter - VTC, Noise margin and aspect ratio of symmetric CMOS inverter.

Combinational Logic Circuit Design **4L**

Circuit design using Static CMOS style – basic gates, design of circuit for product of sum (POS) and sum of product (SOP) expression, full adder; Circuit design using pseudo NMOS logic, TG

Logic, Pass Transistor Logic, Complementary pass transistor logic, Dynamic logic, domino logic, NORA logic.

Sequential Circuit and Semiconductor Memory Design 4L

Bistable Circuit -Design of CMOS S-R and J-K Latch, CMOS Clocked SR and JK Latch /Master – slave JK Flip- flop, CMOS D Flip-flop; 6T SRAM cell and 3T DRAM cell design, EEPROM, Flash Memory.

Module 3: Analog VLSI Circuit Design 7L

Small Signal model of MOSFET; Analog sub-circuits -MOS Switch, Active resistors/MOS Diode, Current source and Sink, Current Mirror; Current and voltage references-voltage divider, Band gap reference (Basic Principle); Switch- Capacitor Circuit – resistance emulation of series; CMOS differential amplifier – design parameters; Output amplifier (basic circuit).

Module 4: Introduction to Embedded System 7L

General purpose processors, RISC and CISC processors, ALU, Von-Neumann and Harvard architecture, MULTI-CORE, Atmega8/16/328P processor, ARM Cortex-III processor, Raspberry Pi, CPLD, FPGA

Module 5: Introduction to Embedded Sensors, Actuators, Networking Standard 7L

Sensor interfacing 3L

Pressure, Temperature, Acceleration, Image, Rain, Proximity, Hall-effect, Ultra-sonic;

Embedded Networking and Standards 4L

RS232, RS485, SPI, USB, PCI, I2C, CAN, Bluetooth, Zigbee

Text Books:

1. Digital Integrated Circuit, J.M. Rabaey, Chandrakasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuits Analysis and Design, S.M.KangandY.Leblebici,TMH.
3. CMOS Analog Circuit Design, Allen and Holberg , Oxford
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi , TMH .
5. Embedded Systems Architecture, Programming and Design, Ral Kamal, TMH, 2008.
6. An Embedded Software Primer, D.E. Simon., Pearson Education, 1999.
7. Design with PIC Microcontrollers, J.B. Peatman, Pearson Education, 1998

Reference Books:

1. Microelectronic Circuits, Sedra and Smith, Oxford
2. Introduction to VLSI Circuits and System, Uyemura , Wiley
3. VLSI Design, Debaprasad Das, Oxford
4. VLSI Design and EDA Tools, Angsuman Sarkar, Swapnadip De, C.K. Sarkar, Scitech
5. VLSI Design Techniques for Analog and Digital Circuits, Geiger, Allen, Strader, TMH
6. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes,
7. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001.

8. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**-**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**3**
CO2	**-**	**3**	**-**	**1**	**-**	**1**	**2**	**-**	**2**	**-**	**-**	**3**
CO3	**2**	**-**	**-**	**-**	**1**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
CO4	**3**	**-**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**
CO5	**-**	**2**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**
Avg.	**2.67**	**2.67**	**2**	**2**	**1.67**	**1.5**	**2.25**	**-**	**2**	**-**	**-**	**3**

COURSE NAME: MEASUREMENT AND CONTROL SYSTEM
COURSE CODE: EE(BME)505C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Concept of Basic Electronics, Laplace Transform.

Course Outcomes:

After successful completion of the course students will be able to

CO1: Understand and explain different measuring instruments, transducers and signal conditioning devices.

CO2: Interpret the concept of transfer functions of physical devices, their modelling and time domain behaviour of closed loop systems.

CO3: Develop mathematical and transfer function models and empirically determine process dynamics for step response data and frequency response data.

CO4: Analyze different measurement and control system for designing multivariable systems.

Course Content:

Module- 1: Basic Measuring Instruments **5L**

Measurements: Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Errors in measurement.

Analog meters: General features, Construction, Principle of operation and torque equation of Moving coil and Moving iron type instruments. Ammeters, voltmeters, Extension of instrument range and multiplier.

Module- 2: Transducers **8L**

Concept of Transducers, Classification of Transducers Primary and Secondary Transducers, Electrical and Mechanical Transducers, Analog and Digital Transducers, Active and passive Transducers. Construction, working principle and application (with diagram and explanation) of RTD, Thermistor, Thermocouple. Potentiometers, Strain gauge, Types of strain gauges, Bridge circuit for strain gauge, Bourden tube, Bellows, Diaphragm. LVDT, measurement for displacement. Capacitive transducers, Application in pressure measurement. Load cell. Tachometer.

Module- 3: Signal Conditioning **5L**

Concept of signal conditioning. Block diagram of AC and DC signal conditioning and working. V to I converter, I to V converter, V to F converter. Instrumentation Amplifier. Filters – Types, frequency response and circuits.

Module- 4: Pilot Devices **3L**

Definition of pilot devices, Function of pilot devices. List of different pilot devices. Construction, working and applications of: Push Button, Limit Switch, Electromagnetic Relay, Pressure switch, Proximity switch.

Module- 5: Introduction to Control Systems **2L**

Concept of feedback and Automatic control, Types and examples of feedback control systems,

Definition of transfer function. Poles and Zeroes of a transfer function.

Module- 6: Mathematical modelling 5L

Writing differential equations and determining transfer function of model of various physical systems including - Translational and Rotational mechanical systems, Basic Electrical systems and transfer function, Electrical analogy of Spring – Mass Dashpot system. Block diagram representation of control systems. Block diagram algebra.

Module- 7: Time domain analysis 8L

Time domain analysis of a standard first and second order closed loop systems. Determination of time domain specifications of systems. Step response of first and second order systems. Stability by pole location. Routh-Hurwitz criteria and applications. Control Actions: Basic concepts of PI, PD and PID control, Steady-state error and error constants.

Text Books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Control System Engineering, I. J. Nagrathand M. Gopal. New Age International Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuoand F. Golnaraghi, 8th Edition, PHI
5. A.K.Sawhney, Electrical and Electronics Measurement and Instrumentation, Dhanpat Rai and Co.
6. H.S.Kalsi, Electronic Instrumentation, Tata McGraw Hill.

Reference Books:

1. Control Engineering Theory and Practice, Bandyopadhyaya, PHI.
2. K. Lal Kishore, Electronic Measurement and Instrumentation, Pearson.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	-	-	-	-	-	-
CO2	3	2	-	-	2	-	-	-	-	-	-	-
CO3	2	2	3	3	-	2	2	-	-	-	-	-
CO4	2	2	3	3	2	-	-	-	-	-	-	2
Avg.	2.5	2	3	2.67	2	2	2	-	-	-	-	2

B. Practical

COURSE NAME: BIOMEDICAL INSTRUMENTATION LAB
COURSE CODE: BME591
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Knowledge of Analog & Digital electronics

Course Outcomes:

After completion of this course the students will be able to

CO1: Illustrate the isolation techniques, delay unit (on-time-off time) design in biomedical instruments.

CO2: Investigate about medical imaging equipment like X-Ray Unit (as one of its kind).

CO3: Analyse the electrode placement for EMG, ECG, EEG wave forms and interpret their characteristics from diagnostic point of views.

CO4: Design power supply unit, bio-potential amplifiers, filters which are essential for biomedical instruments.

List of Experiments:

1. Power isolation: isolation transformer and DC-DC converters
2. Design of Timer circuits (as table multi vibrator): ON delay and OFF delay study
3. Study on ECG electrodes placement and heart rate measurement.
4. ECG processing and analysis
5. EMG processing and analysis
6. EEG processing and analysis
7. Detection of QRS component from ECG signals
8. Study on X-ray radiography systems/X-ray simulator
9. Design of filter circuit/ Power Supply Unit
10. Design of suitable amplifier for bio-signal acquisition
11. Innovative Experiment

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	2	-	-	-	-	-	2
CO2	3	3	3	3	2	-	-	-	-	-	-	-
CO3	3	3	-	3	2	-	-	-	-	2	-	2
CO4	3	3	3	-	-	2	-	-	3	-	-	2
Avg.	3	3	3	3	2	2	-	-	3	2	-	2

COURSE NAME: BIOSENSORS AND TRANSDUCERS LAB
COURSE CODE: BME592
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Fundamentals of sensors and transducers and basic electronics laboratory.

Course Outcomes:

After learning the course, the students should able to

CO1: Illustrate the working principle and characteristics of different types of sensors and transducers useful in medical field.

CO2: Implement different sensors in biomedical instrumentation according to their working mechanism and applications.

CO3: Conduct the different diagnostic methods for identification of human bio-potentials and their necessary instrumentation.

CO4: Select the suitable sensors and transducers applicable for a particular biomedical application.

List of Experiments:

1. Temperature measurement using AD590 IC sensor
2. Study of the characteristics of Thermistor/ RTD
3. Displacement measurement by using a capacitive transducer
4. Study of the characteristics of a LDR
5. Pressure and displacement measurement by using LVDT
6. Study of a load cell with tensile and compressive load
7. Torque measurement using Strain gauge transducer
8. Study the characteristics of piezoelectric transducer
9. Study and characterization of bio-transducers – Pressure, Temperature, Humidity
10. Study and characterization of bio-electrodes – ECG, EMG, EEG
11. Innovative experiment

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	3	2	-	2	2	3	2	-	2
CO4	3	3	3	3	-	-	-	-	3	-	-	2
Avg.	3	3	3	3	2	-	2	2	3	2	-	2

COURSE NAME: DATA STRUCTURE AND ALGORITHM LAB
COURSE CODE: CS(BME)595A
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Basic Mathematics, Programming language

Course Outcomes:

After the completion of this course, students will be able to

CO1: Design and analyze the time and space efficiency of the data structure

CO2: Analyze run-time execution of previous learned sorting methods, including selection, merge sort, heap sort and Quick sort.

CO3: Gain practical knowledge on the applications of data structures.

CO4: Identity the appropriate data structure for given problem.

List of Experiments:

1. Program to Find the Number of Elements in an Array
2. Develop and Implements a menu driven program in C for the following Array operations
   a. Creating Array of N Integer elements.
   b. Display of Array elements with suitable headings.
   c. Inserting an element (ELEM) at a given valid position (POS).
   d. Deleting an element at a given valid position (POS).
   e. Exit
3. Program to convert an Infix Expression into Postfix and Postfix Evaluation
4. Program to implement stack using arrays
5. Program to implement stack using linked list
6. Program to convert infix notation to postfix notation using stacks
7. Program to implement queue using arrays
8. Program to reverse elements in a queue
9. Program to implement circular queue using arrays
10. Program to create add remove and display element from single linked list
11. Program to create add remove and display element from double linked list
12. Program to count number of nodes in linear linked list
13. Program to create add remove and display element from circular linked list
14. Programs to implement stack and queues using linked representation
15. Program to concatenate two linear linked lists
16. Program to accept a singly linked list of integers and sort the list in ascending order.
17. Program to reverse linked list
18. Program to represent polynomial using linked list
19. Program for the creation of binary tree, provide insertion and deletion in c
20. Program for pre-order, post-order and in-order traversals of a binary tree using non reccursive.
21. Program to implement bubble sort program using arrays
22. Program to implement merge sort using arrays
23. Program to implement selection sort program using arrays

24. Program to implement insertion sort program using arrays
25. Program to implement heap sort using arrays
26. Program to implement linear search using arrays
27. Program to implement binary search using arrays
28. Innovative program/ experiment

Text Books:

1. Baluja G S, "Data Structure through C", Ganpat Rai Publication, New Delhi, 2015.
2. Pai G A V, "Data Structures and Algorithms: Concepts, Techniques and Applications", 2ndEdn, Tata McGraw-Hill, 2008.
3. Horowitz E., Sahni S., Susan A., "Fundamentals of Data Structures in C", 2nd Edition, University Press, 2010.

Reference Books:

1. Tremblay J. P., Sorenson P. G, "An Introduction to Data Structures with Applications", 2nd Edn, McGraw-Hill, Inc. New York, NY, USA.
2. Lipschutz Seymour, "Data Structures", 6th Edn, 9th Reprint 2008, Tata McGraw-Hill.
3. Drozdek Adam, "Data Structures and Algorithms in C++", Thomson Learning, New Delhi – 2007.
4. Feller J., Fitzgerald B., "Understanding Open Source Software Development", Pearson Education Ltd. New Delhi

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**-**	**-**	**-**
CO2	**2**	**3**	**2**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**2**	**-**
CO3	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**-**
Avg.	**2.25**	**2.5**	**2.25**	**2.33**	**1.67**	**1.33**	**1.67**	**1.33**	**1.5**	**2**	**2**	**-**

COURSE NAME: VLSI AND EMBEDDED SYSTEM LAB
COURSE CODE: EC(BME)595B
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Sensors, Actuators, System Integration, Cloud and Network Security

Course Outcomes:

After completion of this course students will be able to

CO1: Describe different VTC of the invereter

CO2: Design logic gates and complex digital circuits

CO3: Design digital circuits using VHDL programming

CO4: Design different microcontroller-based circuits and complex real time applications

CO5: Interface different sensors, actuators, and communication devices with the microcontrollers and perform complex real-life projects

List of Experiments:

1. SPICE simulation of CMOS inverter to plot voltage transfer characteristics (VTC) for different values of ratio for VDD=1 V and nano dimensional channel length

2. Design and testing of functionality of the following gate and combinational circuit with the help of SPICE tools at schematic level.

a) CMOS AND/NAND, OR/NOR, XOR/XNOR gate

b) CMOS full adder circuit

3. Design and simulation with the help of VHDL applying suitable modelling style (structural, behavioural, dataflow, mixed) for the following combinational circuits

a) Logic gates b) Full adder using half adder c) 4:1 MUX using 2:1 MUX

4. Design using VHDL for the following Sequential circuits

a) S-R Flip-Flop

b) 8-bit synchronous counter

c) 8 Bit bi-directional register with tri-stated input output

5. VHDL implementation of Finite State Machine.

6. LED blinking using ATMEGA16/ ATMEGA328P/ Raspberry Pi (automatic and switch controlled).

7. Different sensor interfacing with ATMEGA16/ ATMEGA328P/ Raspberry Pi.

8. Different actuator interfacing with ATMEGA16/ ATMEGA328P/ Raspberry Pi.

9. Establishment of different communication protocols like USART/ UART, SPI, I2C, CAN, bluetooth etc.

10. Execution of mini projects like home automation, weather monitoring, drip irrigation etc.

Text Books:

1. Digital Integrated Circuit, J.M.Rabaey, Chandrakasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuits Analysis and Design, S.M.Kang and Y.Leblebici,TMH.
3. CMOS Analog Circuit Design, Allen andHolberg , Oxford
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi , TMH .
5. Embedded Systems Architecture, Programming and Design, Ral Kamal, TMH, 2008.
6. An Embedded Software Primer, D.E. Simon., Pearson Education, 1999.
7. Design with PIC Microcontrollers, J.B. Peatman, Pearson Education, 1998

Reference Books:

1. Microelectronic Circuits, Sedraand Smith, Oxford
2. Introduction to VLSI Circuits and System, Uyemura , Wiley
3. VLSI Design, Debaprasad Das, Oxford
4. VLSI Design and EDA Tools, Angsuman Sarkar, Swapnadip De, C.K. Sarkar, Scitech
5. VLSI Design Techniques for Analog and Digital Circuits, Geiger, Allen, Strader, TMH
6. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes,
7. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001.
8. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**-**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**3**
CO2	**-**	**3**	**-**	**2**	**-**	**2**	**2**	**-**	**2**	**-**	**-**	**3**
CO3	**2**	**-**	**-**	**-**	**1**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
CO4	**3**	**-**	**2**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**
CO5	**-**	**2**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**
Avg.	**2.67**	**2.33**	**2**	**2.5**	**1.67**	**2**	**2.25**	**-**	**2**	**-**	**-**	**3**

COURSE NAME: MEASUREMENT AND CONTROL SYSTEM LAB
COURSE CODE: EE(BME)595C
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Familiarization with electronic instruments, MATLAB.

Course Outcomes:

After successful completion of the course students will be able to

CO1: Illustrate characteristics of different measuring instruments, transducers and signal conditioning devices using simulation tools/ hardware KIT.

CO2: Demonstrate time domain behavior of closed loop systems with/ without controllers.

CO3: Simulate various process models and determine their response.

CO4: Interpret the results of various control systems and draw meaningful conclusions.

List of Experiments:

1. To measure linear displacement by LVDT and plot characteristics.
2. To measure displacement by Strain gauge and plot characteristics.
3. To study the following signal conditioning circuits and observe and plot the output (i) V to I Converter, (ii) I to V Converter, (iii) V to F Converter using Op-AMP 741.
4. To plot frequency response of Active filters (any two):- I) Low pass filter II)High pass filter III) Band pass filter Iv) Band stop filters using KIT/ MATLAB.
5. Familiarization with MATLAB control system tool box, MATLAB - simulink tool box.
6. Determination of Step response for first order and Second order system with unity feedback using MATLAB
7. Simulation of Step response and Impulse response for type-0, type-1 and Type-2 system with unity feedback using MATLAB.
8. To study the position control system using servomotor.
9. Determination of PI, PD and PID controller action of first order simulated process using KIT/ MATLAB.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO4	**2**	**2**	**-**	**3**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
Avg.	**2**	**2**	**3**	**3**	**2.5**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

3rd Year 6th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	BME601	Analytical and Diagnostic Equipment	3	0	0	3	3
2	ENGG	Major	BME602	Biosignal Processing	3	0	0	3	3
3	ENGG	Major	BME603	Medical Imaging Systems - II	3	0	0	3	3
4	ENGG	Major	BME604A	Biophysics and Biochemistry	3	0	0	3	3
			BME604B	Nanobiotechnology					
			BME604C	Tissue Engineering					
5	ENGG	Minor	CS(BME)605A	Database Management System	3	0	0	3	3
			EC(BME)605B	Microprocessor and Microcontroller					
			CS(BME)605C	Soft Computing					
B. Practical									
6	ENGG	Major	BME691	Analytical and Diagnostic Equipment Lab	0	0	2	2	1
7	ENGG	Major	BME692	Biosignal Processing Lab	0	0	2	2	1
8	ENGG	Minor	CS(BME)695A	Database Management System Lab	0	0	2	2	1
			EC(BME)695B	Microprocessor and Microcontroller Lab					
			CS(BME)695C	Soft Computing Lab					
9	PRJ	Project	BME681	Minor Project - II	0	0	4	4	2
10	PRJ	Internship	BME682	Internship	0	0	0	0	1
Total of Theory and Practical Courses								**25**	**21**

A. Theory

COURSE NAME: ANALYTICAL AND DIAGNOSTIC EQUIPMENT
COURSE CODE: BME601
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Biomedical Instrumentation

Course outcomes:

After completion of this course the students will be able to

CO1: Apply the fundamentals of chemical and scientific theories in analytical & diagnostic equipment.

CO2: Illustrate the significance of all the analytical & diagnostic equipment used in Biomedical Engineering.

CO3: Analyze the working principle, functional and constructional features of different analytical & diagnostic medical instruments used for measuring various physiological parameters of human body.

CO4: Select the proper analytical or diagnostic techniques for measuring specific medical parameters.

Course Content:

Module- 1: Clinical Equipment 10L

Principles of photometric measurement, Optical filters, Colorimeter, Spectrometer, Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer- Autoanalyzer, Coagulometer, Ion Analyzer, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-principles and applications. Methods of cell counting Flow cytometry, Coulter Counters, automatic recognition and differential counting of cells.

Module- 2: Cardiac Function Measurement 10L

Blood pressure apparatus, Blood gas analyzers and Oximeters

Sphygmomanometer, Automated indirect and specific direct method of B.P. monitor. Blood pH measurement, Blood pCO2 measurement, Blood pO2 measurement, a complete blood gas analyzer, Fiber optic based blood gas sensors, Oximeter and its Principles, Ear oximeter, Pulse oximeter, Intravascular oximeter.

Blood Flow meters

Electromagnetic blood flow meter, Ultrasonic blood flow meter-Transit time and Doppler blood flow meter, Cardiac output measurement-Dye dilution method and Impedance technique.

Module- 3: Pulmonary Function Measurement 6L

Respiratory volumes and capacities, Compliance and related pressure, Spirometer,

Pneumotachometer-different types, Measurement of respiration rate-impedance pneumograph / plethysmograph, apnea detector.

Module- 4: Endoscopy **6L**

Basic endoscopic equipment, Fiber optic instruments and video-endoscopes, Accessories-illumination, instrument tips, instrument channels, tissue sampling devices, suction traps and fluid-flushing devices, Various endoscopic applications. Maintenance and Storage.

Module- 5: Computer Based Instruments **4L**

Computers in Biomedical Instrumentation, Types, Computer Interfacing, Computer Network.

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill.
2. R. S. Khandpur "Handbook of Analytical Instruments", 3rd Edition, Tata McGraw Hill.
3. J.J. Car and J.M. Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
4. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall, India.

Reference Books:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
2. J. Webster, "Bioinstrumentation", Wiley and Sons.
3. Joseph D. Bronzino, "The Biomedical Engineering handbook", CRC Press

CO - PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO3	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
Avg.	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**2**

COURSE NAME: BIOSIGNAL PROCESSING
COURSE CODE: BME602
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Biomedical Signal and Systems

Course Outcomes:

After completion of this course students will be able to

CO1: Illustrate the fundamental techniques and applications of digital signal processing withemphasis on biomedical signals.

CO2: Apply the different computation techniques and algorithms based on discrete time signals.

CO3: Analyze the characteristics and performance requirements of BDSP system.

CO4: Identify the different digital filters using designing prototype to effectively perform BDSP operation.

Course Content:

Module- 1: Concept of Biosignal 9L

Signals and systems: Continuous time (CT) signals, Discrete time (DT) signals, periodic, aperiodic, random, energy and power signals, step, ramp, impulse and exponential function, Transformation in independent variable of signals: time scaling, time shifting and time inverting, classification and properties of systems, LTI systems - convolution and stability, physiological signals and their properties, Time invariant and time varying physiological systems.

Module- 2: Signal, System and Spectrum Analysis 9L

Characteristics of some dynamic signals, Basic concepts and development of the Fourier Series, Determination of the Fourier series representation of Continuous and Discrete time periodic signal, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), ECG signal analysis Filters- IIR and FIR filters. Linear phase filter, Estimation of convolution of real time and discretesignals.

Module- 3: Discrete Time Modeling of Signals and Design of Digital Filters 9L

Evaluation of DFT, Properties of DFT, Circular convolution using DFT, IDFT, Realization of Digital Filters: Applications of Z – Transforms, Solution of Difference Equations of Digital Filters, System Function, Digital filter design, Difference equation, Direct form –I, Direct form-II, Cascaded Form.

Module- 4: Biosignal Analysis 9L

Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques – Finite word length effects in digital Filters: Errors, Limit Cycle, Noise Power Spectrum, Back propagation neural network-based classification. Application in Normal versus Ectopic ECG beats.

Text Books:

1. S. Sharma, Digital Signal Processing, S K Kataria and Sons.
2. P. Ramesh Babu, Digital Signal Processing, SCITECH.
3. S. Salivahanan, A. Vallavaraj and C. Gnanapriya, Digital Signal Processing, TMH.
4. D.C Reddy, Biomedical Digital Signal processing, TMH

Reference Books:

1. J.R. Johnson, Introduction to Digital Signal Processing, PHI.
2. T. Bose, Digital Signaland Image Processing, Wiley.
3. S.K. Mitra, Digital Signal Processing, TMH.
4. J.G. Proakis and D.G. Manolakis, Digital Signal Processing

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-		-	-	2
CO3	3	3	-	-	-		-	-	-	-	-	-
CO4	3	3	3	3	2	-	-	-	-	-	-	2
Avg	3	3	3	3	2	-	-	-	-	-	-	2

COURSE NAME: MEDICAL IMAGING SYSTEMS - II
COURSE CODE: BME603
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of basic medical imaging techniques

Course Outcomes:

After completion of this course the students will be able to

CO1: Determine the physics and principles behind the operations of medical imaging equipment used for advanced.

CO2: Illustrate the applications of physical processes to the diagnosis and treatment of disease, including an understanding of contemporary developments in professional practice.

CO3: Identify the basics of imaging modalities based on technological advancements and thus differentiate among them.

CO4: Interpret the most effective advanced imaging modality for a particular organ and its required safety precautions.

Course Content:

Module- 1: Introduction to Advanced Imaging 6L

Introduction to emission tomography, basic physics of radioisotope imaging, various modes of gamma irradiation, Compton cameras for nuclear imaging, Radio nuclides for imaging, nuclear decay and energy emissions, brief of radionuclide production: Cyclotron and Nuclear Reactor, Radiation detectors, Pulse height analyzer.

Module- 2: Radionuclide Imaging 4L

Basic principles of Rectilinear scanners, Gamma Camera, PET, SPECT, Scintigraphy, Dual isotope imaging.

Module- 3: Magnetic Resonance Imaging (MRI) 10L

Principles of nuclear magnetism, RF magnetic field and resonance, magnetic resonance (MR) signal, nuclear spin relaxations, gradient pulse, slice selection, phase encoding, frequency encoding, spin echoes, gradient echoes, K-space data acquisition and image reconstruction. MRI scanner hardware: magnet, gradient coil, RF pulse transmission and RF signal reception. Diagnostic utility and clinical MRI, functional MRI, magnetic resonance angiography (MRA), magnetic resonance spectroscopy (MRS), diffusion MRI, bio-effects and safety levels.

Module- 4: Other Imaging Techniques 10L

Fluoroscopy, Angiography: Types, Infrared (IR) Imaging, Infrared Photography, Thermography – Scanning systems, Liquid Crystal Thermography, Microwave Thermography: types and modes, Optical Coherence Tomography (OCT), Electro-oculography, Retinography – Basic Principles and Applications.

Module- 5: Computers in Imaging Systems **6L**

Computer systems: operating systems and its various generations and transfer of images: file formats; Radiological Information System, Hospital Information System, Picture archiving and communication systems, internet and intranet, teleradiology, medical image processing system-basic introduction.

Text Books:

1. Carrand Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J. Webster, "Bioinstrumentation", Wiley and Sons

Reference Books:

1. Dowsett, Kenny and Johnston, "The Physics of Diagnostic Imaging", Chapman and Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford and Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey and Meredith, "Fundamental Physics of Radiology", John Wright and Sons.
4. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	3	-	3	-	-	-	3
CO3	3	-	-	2	-	-	-	-	-	-	-	-
CO4	3	2	-	2	-	2	2	2	-	-	-	2
Avg	3	2	-	2	-	2.5	2	2.5	-	-	-	2.5

COURSE NAME: BIOPHYSICS AND BIOCHEMISTRY
COURSE CODE: BME604A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Fundamental Physics and Chemistry, Cell Biology.

Course Outcomes:

After completion of this course students will be able to

CO1: Articulate the principles of fundamental processes of Biochemistry and Biophysics in terms of the life functions.

CO2: Correlate the complex biochemical and biophysical processes related to formation of cellular structures, structural-functional relationships of biomolecules, biochemical and biophysical activity.

CO3: Analyse intricate affairs and problems related to radioactivity, electrical stimulus, bioelectrical activity.

CO4: Illustrate appropriate engineering techniques and tools to address complex biophysical, biochemical and bio-molecular activities in-terms of limitations and effective solutions.

Course Content:

Module- 1: Biological Principles **5L**

Composition and properties of cell membrane, membrane transport, body fluid, electrolytes, filtration, diffusion, osmosis, electrophoresis, plasmapheresis, radioimmunoassay, Photochemical reaction, laws of photochemistry, fluorescence, phosphorescence.

Module- 2: Bioelectricity **5L**

Membrane potential, Action potential, Electrical properties of membrane, capacitance, resistance, conductance, dielectric properties of membrane.

Module- 3: Electrical Stimulus and Biophysical Activity **6L**

Patient safety, electrical shock and hazards, leakage current, Electrical activity of heart (ECG), Electrical activity of brain (EEG), Electroretinogram (ERG), Electro-occulogram (EOG), Electromyogram (EMG).

Module- 4: Radioactivity **4L**

Ionizing radiation, U-V and IR radiations, Production of radioisotopes, Radioactive decay, Half-life period.

Module- 5: Macromolecules **8L**

Classification and functions of carbohydrate. Glycolysis. TCA cycle. ATP synthesis. Classification and functions of proteins. Architecture of protein. Classification of amino acid. Oxidative and non-oxidative deamination, transamination. Classification and functions of lipids. Biosynthesis of long chain fatty acid. Oxidation and degradation of fatty acid.

Module- 6: Enzymes and Nucleic acid **8L**

Chemical nature and broad classification of enzymes, M-M kinetics, Isozymes and Allosteric enzymes. Enzyme Inhibition. Structure of DNA, DNA Replication, Transcription, Translation.

Text Books:

1. Bio-Physics by Roland Glaser- Springer, 2nd printing edition (November 23, 2004).
2. Fundamentals of Biochemistry: Life at the Molecular Level by Donald J Voet, Judith G Voet and Charlotte W Pratt- Wliey, 2nd Edition (March 31, 2005).
3. The Biomedical Engineering Hand Book- 3rd Edition- (Biomedical Engineering Fundamentals)- Joseph D Bronzino- CRC Press- Taylor Francis- 2006 (Section III- Bio-Electrical Phenomena).

Reference Books

1. Lehninger Principles of Biochemistry by David L Nelson and Michael M Cox, 4th Edition (April 23, 2004).
2. Text Book of Medical Physiology- Guyton.
3. Radiation Biophysics by Edward L Alpen- Academic Press, 2nd Edition.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**-**	**-**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**3**
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**2.67**

COURSE NAME: NANOBIOTECHNOLOGY
COURSE CODE: BME604B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Fundamental knowledge of physics, biochemistry, biomaterials and nano-materials.

Course Outcomes:

After completion of this course students will be able to

CO1: Understand the basics of bio-nanotechnology and bio-machines.

CO2: Demonstrate a comprehensive understanding of state-of-the-art methods for fabrication, characterization and handling of nano-materials.

CO3: Explain the functional principles of nanotechnology and the interaction between biomolecules and nanoparticle surface.

CO4: Apply the concept on nanotechology in the field of Biomedical Engineering.

Course Content:

Module- 1: Bio-Nano machines and Their Basics 5L

Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines: Thymidylate Synthetase, ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen.

Module- 2: Synthesis of Biomolecules and Interphase Systems 8L

Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures. Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design. Interphase systems of devices for medical implants –Microfluidic systems –Microelectronic silicon substrates –Nano-biometrics –Introduction –Lipids as nano-bricks and mortar: self-assembled nanolayers**.**

Module- 3: Functional Principles of Nano biotechnology 7L

Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials, Bimolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels, ABC Transporters and Bactreriorhodapsin, Bimolecular sensing, Self-replication, Machine-Phase Bionanotechnology Protein folding; Self-assembly, Self-organization, Molecular recognition and Flexibility of biomaterials.

Module- 4: Protein and DNA based Nanostructures 8L

Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles – Magnetosomes, DNA based nanostructures –

Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing.

Module- 5: Applications of Nano biotechnology 8L

Semiconductor (metal) nanoparticles and nucleic acid and protein-based recognition groups – Application in optical detection methods – Nanoparticles as carrier for genetic material – Nanotechnology in agriculture – Fertilizer and pesticides. Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors, Future of Bionanotechnology.

Text Books:

1. C. M. Niemeyer, C. A. Mirkin, ―Nanobiotechnology: Concepts, Applications and Perspectives‖, Wiley – VCH, (2004).
2. David S Goodsell, "Bionanotechnology‖, John Wiley and Sons, (2004).

Reference Books:

1. T. Pradeep, ―Nano: The Essentials, McGraw – Hill education, (2007).
2. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact, Wiley – VCH, (2005).

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	1	-	-	-	-	1
CO2	3	3	2	-	2	2	-	1	3	3	1	2
CO3	3	2	2	2	2	-	-	1	-	-	2	2
CO4	3	2	2	-	2	2	2	2	2	2	3	3
Avg.	3	2.25	2	2	2	2	1.5	1.33	2.5	2.5	2	2

COURSE NAME: TISSUE ENGINEERING
COURSE CODE: BME604C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of cell biology, biomaterials

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand the biological requirement for tissue engineering systems and also specify the different types of biodegradable biomaterials that can be used in tissue engineering applications.

CO2: Discuss the complex interactions between biomaterials, cells and signals in biological systems using stem cells, proteomics and bioreactors.

CO3: Design and fabricate scaffolds using advanced manufacturing technologies including 3D printing for growing biological materials.

CO4: Develop engineered tissue like cardiovascular tissues and also evaluate the patterning of bio-mimetic substances.

Course Content:

Module- 1: Introduction to Tissue Engineering 6L

Introduction – definitions - basic principles - structure-function relationships –Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies –Tissue Morphogenesis and Dynamics- Stem Cells and Lineages - Cell-Cell Communication.

Module- 2: Tissue Culture Basics 7L

Primary cells vs. cell lines - sterile techniques – plastics – enzymes - reactors and cryopreservation - Synthetic Biomaterial Scaffolds- Graft Rejection – Immune Responses-Cell Migration-Controlled Drug Delivery- Micro Technology Tools.

Module- 3: Scaffold Formation 8L

Oxygen transport - Diffusion - Michalies-Menten kinetics - oxygen uptake rates -limits of diffusion - Principals of self-assembly - Cell migration - 3D organization and angiogenesis - Skin tissue engineering –Introduction - scar vs. regeneration - split skin graft -apligraft. Engineered Disease Models- Tissue Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring, Hernia.

Module- 4: Cardiovascular Tissue Engineering 8L

Blood vessels structure – vascular grafts – Liver tissue engineering – Bioartificial liver assist device – shear forces – oxygen transport – plasma effects – Liver tissue engineering – Self-assembled organoids – decelluarized whole livers – Stem cells – basic principle – embryonic stem cells – Induced pluripotent stem cells -Material Biocompatibility – Cell Mechanics – Vascularization- Stem Cell Therapies.

Module- 5: Patterning of Biomimetic Substrates 8L

Patterning of biomimetic substrates with AFM lithography primarily focusing on DPN-Nano

templating polymer melts - Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments - Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications -Nanotopography techniques for tissue-engineered scaffolds

Text Books:

1. Ketul Popat *"Nanotechnology in Tissue Engineering and Regenerative Medicine"* CRC Press Taylor and Francis 2011.
2. Cato T. Laurencin, Lakshmi S *"Nanotechnology and Tissue Engineering: The Scaffold* "CRC Press Taylor and Francis 2008.

Reference Books:

1. Kun Zhou, David Nisbet, George Thouas, Claude Bernard and John Forsythe "*Bio-nanotechnology Approaches to Neural Tissue Engineering*", NC-SA 2010.
2. Nair "*Biologically Responsive Biomaterials for Tissue Engineering",* Springer Series in Biomaterials Science and Engineering, Vol. 1 Antoniac, Iulian (Ed.) 2012.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2-**
CO4	**3**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
Avg.	**3**	**2**	**3**	**1.5**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: DATABASE MANAGEMENT SYSTEM
COURSE CODE: CS(BME)605A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Logic of programming language, Basic concepts of data structure and algorithms.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand Database Management System, explain fundamental elements of a database management system, compare the basic concepts of relational data model, entity-relationship model, file organization and use appropriate index structure.

CO2: Apply efficient query optimization techniques, suitable transaction management, concurrency control mechanism and recovery management techniques.

CO3: Analyze the database design techniques and improve the design by normalization.

CO4: Design entity-relationship diagrams to represent simple database application scenarios, translate entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data.

Course Content:

Module- 1: Introduction **2L**

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module- 2: Entity-Relationship and Relational Database Model **7L**

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, case study on E-R Model. Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module- 3: SQL and Integrity Constraints **6L**

Concept of DDL, DML, DCL. Basic Structure, set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Module- 4: Relational Database Design **8L**

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF, Case Study.

Module- 5: Internals of RDBMS **7L**

Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols; two phase locking, Dead Lock handling.

Module- 6: File Organization & Index Structures **6L**

File & Record Concept, placing file records on Disk, Fixed and Variable Sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes.

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.

Reference Books:

1. Fundamentals of Database Systems", Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing.
2. Ramakrishnan: Database Management System, McGraw-Hill

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	-	-	-	-	-	-	-	1
CO2	3	3	1	1	2	-	-	-	-	-	-	2
CO3	3	3	2	2	1	-	-	-	-	-	-	3
CO4	3	3	3	3	2	1	1	2	1	-	-	3
Avg.	2.75	3	1.75	1.75	1.67	1	1	2	1	-	-	2.25

COURSE NAME: MICROPROCESSOR AND MICROCONTROLLER
COURSE CODE: EC(BME)605B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge in Digital Electronics

Course Outcomes:

After completion of this course, students will be able to

CO1: Correlate the architecture, instructions, timing diagrams, addressing modes, memory interfacing, interrupts, data communication of 8085

CO2: Interpret the 8086 microprocessor- Architecture, Pin details, memory segmentation, addressing modes, basic instructions, interrupts

CO3: Recognize 8051 micro controller hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts

CO4: Apply instructions for assembly language programs of 8085, 8086 and 8051, 8255, 8253, 8251.

Course Content:

Module- 1: Introduction to Microcomputer based system 10L

History of evolution of Microprocessor and Microcontrollers and their advantages and disadvantages, Architecture of 8085 Microprocessor. Address/data bus De multiplexing, status Signals and the control signal generation. Instruction set of 8085 microprocessors, Classification of instruction, addressing modes, and timing diagram of the instructions (a few examples).

Module- 2: 3L

Assembly language programming with examples, Interrupts of 8085 processors, programming using interrupts, Stack and Stack Handling, Call and subroutine, DMA, Memory interfacing with 8085

Module- 3: 8086 Microprocessor 8L

8086 Architecture, Pin details, memory segmentation, addressing modes, Familiarization of basic Instructions, Interrupts, Memory interfacing, ADC / DAC interfacing. Assembly language programming with 8086: Addition, Subtraction, Multiplication, Block Transfer, ascending order, descending order, Finding largest and smallest number etc.

Module- 4: 8051 Microcontroller 4L

8051 architectures, hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts, Memory interfacing, ADC / DAC interfacing.

Module- 5: Assembly language Programming using 8051 4L

Moving data: External data moves, code memory read only data moves, PUSH and POP opcodes, data exchanges; Logical operations: Byte-level, bit-level, rotate and swap operations; Arithmetic operations: Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic; Jump and call instructions: Jump and call program range, jumps, calls

and subroutines, interrupts and returns.

Module- 6: Support IC chips **5L**

8255, 8253 and 8251: Block Diagram, Pin Details, Modes of operation, control word(s) format.

Module-7: Brief introduction to PIC microcontroller (16F877) **2L**

Architecture, PIN details, memory layout.

Text Books:

1. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International
2. The 8051 microcontroller - K. Ayala, Thomson
3. Microprocessors and interfacing – D. V. Hall,Tata McGraw-hill
4. Ray and Bhurchandi, Advanced Microprocessors and Peripherals, TMH
5. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson
6. An Introduction to Microprocessor and Applications –Krishna Kant, Macmillan

Reference Books:

1. Microprocessors and microcontrollers - N. Senthil Kumar, M. Saravanan and Jeevananthan, Oxford university press
2. 8086 Microprocessor –K Ayala, Cengage learning
3. The 8051 microcontrollers – Uma Rao and Andhe Pallavi ,Pearson

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	2	2	1	2	3
CO2	2	3	2	2	2	2	1	2	3	3	2	3
CO3	3	2	3	3	1	2	1	3	2	2	2	3
CO4	2	3	3	3	2	2	2	2	1	2	2	3
Avg.	2.5	2.75	2.5	2.5	2	2	1.75	2.25	2	2	2	3

COURSE NAME: SOFT COMPUTING
COURSE CODE: CS(BME)605C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, set theory and Introduction to Computing.

Course Outcomes:

After completion of the course, students will be able to

CO1: Define and demonstrate a comprehensive understanding of the principles and foundations of Soft Computing, including Fuzzy Logic Systems, Neural Networks, Evolutionary Computation, and Hybrid Systems.

CO2: Apply Fuzzy Logic concepts to model uncertainty in biomedical systems, design Fuzzy Inference Systems, and implement fuzzy control strategies for improving the performance of biomedical systems.

CO3: Design and analyze Neural Networks for biomedical applications, demonstrating proficiency in supervised and unsupervised learning, and understanding the role of deep learning in medical imaging.

CO4: Implement Evolutionary Computation techniques, such as Genetic Algorithms and Genetic Programming, to optimize parameters in biomedical systems, and design hybrid intelligent systems for solving real-world biomedical engineering problems.

Course Content:

Module-1: Introduction to Soft Computing 4L

Overview of Soft Computing, Fuzzy Logic Systems, Neural Networks, Evolutionary Computation, Hybrid Systems, Applications of Soft Computing in Biomedical Engineering, Difference between Hard and Soft computing, Applications of Soft Computing.

Module-2: Fuzzy Logic in Biomedical Systems 10L

Basics of Fuzzy Logic, Fuzzy Sets and Membership Functions, Fuzzy Inference Systems, Applications in Medical Diagnosis, Fuzzy Control in Biomedical Systems, Case Studies. Fuzzy Relation, Fuzzification, Min-max Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

Module-3: Neural Networks 10L

Introduction to Artificial Neural Networks (ANN), Supervised Learning in Neural Networks,

Learning rules and various activation functions, Single layer Perceptron, Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back-propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications. Unsupervised Learning and Self-Organizing Maps, Neural Networks for Pattern Recognition, Applications in Medical Imaging,

Deep Learning in Biomedical Engineering.

Module-4: Evolutionary Computation in Biomedical Optimization 10L

Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Multi objective Gas, Genetic Programming (GP), Evolutionary Strategies, Applications in Parameter Optimization, Evolutionary Computation in Medical Image Processing.

Module-5: Hybrid Systems and Biomedical Applications 8L

Integration of Fuzzy Logic, Neural Networks, and Evolutionary Computation, Neuro-Fuzzy Systems, Hybrid Intelligent Systems in Healthcare, Case Studies and Real-world Applications, Ethical Considerations in Soft Computing in Biomedical Engineering.

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	2	-	1	1
CO2	2	3	2	2	-	-	-	-	1	-	-	1
CO3	2	3	2	2	1	-	-	-	1	-	-	1
CO4	3	3	3	2	2	-	-	-	2	-	-	1
Avg.	2.5	3	2.25	2	1.67	-	-	-	1.5	-	1	1

B. Practical

COURSE NAME: ANALYTICAL AND DIAGNOSTIC EQUIPMENT LAB
COURSE CODE: BME691
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Knowledge in Basic Electronics & Biomedical Instrumentation.

Course Outcomes:
After completion of this course the students will be able to:

CO1: Apply the fundamental principles and use of different biomedical analytical devices with concept of measurement of different sample concentration & some physiological parameters.

CO2: Implement the acquired skills to recognize the different biomedical diagnostic devices with their structures, functions and applications.

CO3: Analyze the working principle of different therapeutic devices and how they are applied to give physiotherapy to patients.

CO4: Investigate the problems, circuit performance in the areas of analysis, diagnosis & therapy.

List of Experiments:

1. Lead selection circuits
2. Study on pulse rate meter
3. Study on colorimeter/spectrophotometer
4. Study on electronic BP and calibration procedure
5. Study on Pacemaker Circuits/ Pacemaker simulator
6. Study on pulmonary function analyzer-spirometer
7. Study on respiratory ratemeterand apnea detection
8. Study on diathermy unit (ultrasoundand short-wave)
9. Study of ultrasonic devices -transmitter and detector
10. Study on blood flow velocity measurement-ultrasonic method
11. Innovative experiment

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	2	-	-	-	-	-
CO3	3	3	-	-	2	-	2	-	-	-	-	-
CO4	3	3	3	3	2	-	-	-	3	2	-	3
Avg.	3	3	3	3	2	-	2	-	3	2	-	3

COURSE NAME: BIOSIGNAL PROCESSING LAB
COURSE CODE: BME692
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Knowledge in Biomedical Signal and Systems

Course Outcomes:

After completion of this course the students will be able to:

CO1: Understand the fundamental techniques and applications of DSP with emphasis on biomedical signals.

CO2: Implement the steps for collecting raw file of biomedical signal from specific data base or through DAQ.

CO3: Analyze the applications of practical signal processing algorithm used in biomedical signal processing.

CO4: Design adaptive filters and algorithms for various applications of Biomedical Signal Processing.

List of Experiments:

1. Study on generalized Waveforms and Plot.
2. Study on Biomedical Signal Database.
3. Frequency Domain Description of Signals: DFT (sinusoidal signals).
4. Design and Application of Digital Filters: FIR and IIR Filters.
5. Implementation of a Practical DSP System for ECG Signals.
6. Implementation of a Practical DSP System for EMG Signals.
7. Implementation of a Practical DSP System for EEG Signals.
8. Implementation of signal processing technique on the data acquired through DAQ.
9. Introduction of coding for discrete wavelet transforms.
10. Implementation of DSP in biomedical signal processing throughTMS3206713.
11. Innovative experiment.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	2	-	-	2
CO2	2	3	3	2	2	-	-	2	1	-	-	-
CO3	2	3	2	3	2	-	-	1	-	-	-	-
CO4	3	3	3	2	3	2	2	2	-	-	2	1
Avg.	2.5	2.75	2.5	2.25	2.33	2	2	1.67	1.5	-	2	1.5

COURSE NAME: DATABASE MANAGEMENT SYSTEM LAB
COURSE CODE: CS(BME)695A
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

Course Outcomes:

After completion of this course students will be able to

CO1: Apply SQL and PL/SQL for processing database

CO2: Analyze the database using queries to retrieve records

CO3: Develop solutions using database concepts for real time requirements.

List of Experiments:

1. Study of Backend Tool – Oracle.
2. Data Definition Language (DDL) commands in RDBMS.
3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
4. High-level language extension with Cursors.
5. High level language extension with Triggers
6. Procedures and Functions.
7. Embedded SQL.
8. Database design using E-R model and Normalization.
9. Mini project (Application Development using Oracle and Visual Basic)
    i. Inventory Control System.
    ii. Material Requirement Processing
    iii. Hospital Management System
    iv. Railway Reservation System
    v. Personal Information System
    vi. Web Based User Identification System
    vii. Time-table Management System

Text Books:

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition.

Reference Books:

2. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.
3. SQL & PL/SQL for Oracle 10g, Black Book, Dr.P.S. Deshpande.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	-	-	-	-	-	-	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2
CO3	3	3	3	3	3	1	2	2	2	-	-	3
Avg.	3	3	2.67	2.33	3	1	2	2	2	-	-	2.33

COURSE NAME: MICROPROCESSOR AND MICROCONTROLLER LAB
COURSE CODE: EC(BME)695B
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Knowledge in Digital Electronics

Course Outcomes:

After completion of this course the students will be able to

CO1: Solve small assignments using the 8085 basic instruction sets and memory mapping through trainer kit and simulator.

CO2: Write 8085 assembly language programs like Addition, Subtraction, Multiplication, Square, Complement, Look up table, Copying a block of memory, Shifting, Packing and unpacking of BCD numbers, Ascending order, Descending order etc. using trainer kit.

CO3: Validate the interfacing technique using 8255 trainer kit through subroutine calls and IN/OUT instructions like glowing LEDs accordingly, stepper motor rotation etc.

CO4: Test fundamental of 8051 programs using the trainer kit.

List of Experiments:

1. Write a program in 8085 microprocessors to swap the content of two register B and C containing the values 08H and 06H respectively.
2. Write a program in 8085 microprocessors to add two number 09H and 08H and store the result in 9085H location
3. Write a program in 8085 microprocessors to subtract 05H from 09H and store the result in 8072H. Write a program in 8085 microprocessor to add five (5) numbers and store the result in memory location 9071H. The numbers are stored from 9061H to 9065H location. The numbers are stored in 5 consecutive memory locations given below.
4. Write a program in 8085 microprocessors to multiply 08H with 03H and store the result in 9065H location.
5. Write a program in 8085 microprocessors to divide 07H by 03H and store the quotient in 9075H and reminder in 9076H memory location.
6. Write a program in 8085 microprocessors to add six (6) numbers and store the result in memory location 9071H and 9061H.The numbers are stored from 9050H to 9055H location. The numbers are stored in 6 consecutive memory locations given below.
7. Write a program in 8085 microprocessors of shifting block of five (5) data from 9055H location to 9080H location.
8. Write a program in 8085 microprocessors to count ones (1) in 8 bit data. The 8 bit no. is store in memory location 9070H.Store the counting result in memory location 9080H and draw the flow chart.
9. Write a program in 8085 microprocessor to interchange the nibble of a 8 bit number stored in memory location 9006H and store the interchanged number into memory location 9060H.[for example 78H will be 87H]. 1 nibble= 4 bits
10. In 8086 microprocessor write a program to add two numbers 0465H and 2010H and store the result at different registers.

11. In 8086 microprocessor write a program to subtract two numbers 0006H from 0009H and store the result at different registers.
12. In 8086 microprocessors write a program to multiply between 24H and 45H and store the result at different registers
13. In 8086 microprocessor write a program to divide 0009H by 0002H and store the quotient and remainder at different registers.
14. Configure 8255 A such that port A and port B as output port. Display the value of 45H through port A and 56H through port B. Execute the program at 8000H and draw the flow chart.

    a. Port A Equ. 80H, b. Port B Equ. 81H, c. Control Register Equ. 83H
15. Configure 8255 A such that port A as an input and port B as output port. Take the input value through DIP switch of Port A. Display the input value though port B. Execute the program at 8000H, and draw the flow chart. Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H
16. Write a program in 8051 microcontrollers to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.
17. Write a program in 8051 microcontrollers to send 55h to port 1 and port 2 and check the value of ports and draw the flow chart.
18. Write a program in 8051 microcontrollers to multiply 06H by 05H and store the result in RAM address 46H.
19. Innovative experiment

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**2**	**2**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**3**	**1**	**3**	**3**
Avg.	**2.75**	**2.75**	**2.5**	**2.25**	**1.75**	**1.25**	**1**	**1**	**3**	**1.5**	**2.25**	**3**

COURSE NAME: SOFT COMPUTING LAB
COURSE CODE: CS(BME)695C
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Mathematics, set theory and Introduction to Computing.

Course Outcomes:

After completion of this course student will be able to

CO1: Define and demonstrate a comprehensive understanding of the principles and foundations of Soft Computing, including Fuzzy Logic Systems, Neural Networks, Evolutionary Computation, and Hybrid Systems.

CO2: Apply Fuzzy Logic concepts to model uncertainty in biomedical systems, design Fuzzy Inference Systems, and implement fuzzy control strategies for improving the performance of biomedical systems.

CO3: Design and analyze Neural Networks for biomedical applications, demonstrating proficiency in supervised and unsupervised learning, and understanding the role of deep learning in medical imaging.

CO4: Implement Evolutionary Computation techniques, such as Genetic Algorithms and Genetic Programming, to optimize parameters in biomedical systems, and design hybrid intelligent systems for solving real-world biomedical engineering problems.

Course Content:

List of programs

- Overview of Matrix, Matrix Operations, Giving input to Matrix, Displaying elements of Matrix.
- Performing Operations on Matrix like Addition, Subtraction, and Multiplication.
- Performing Transpose Operations on Matrix.
- Plotting of mathematical functions like log(x), sin(x), cos(x). etc
- Write a Program in MATLAB to check whether a number is even or odd
- Write a program in MATLAB to find out the sum of "N" natural numbers.
- Write a Program in MATLAB to generate the fibonacci series upto N , where N is the desired value input by user
- Write a MATLAB program to solve MATRIX based problems.
- Write a MATLAB Program to implement LMS Learning rule.
- Write a MATLAB program to verify McCulloch OR Function.
- Write a MATLAB program to verify Hebb's Rule.
- Write a MATLAB program to implement various Fuzzy Operations. (Eg Union , Intersection , Complement, XOR Operation) For two Fuzzy Set

P = (0.3/a) + (0.9/b) + (1.0/c) + (0.7/d) + (0.5/e) + (0.4/f) + (0.6/g)
Q = (1/a) + (1/b) + (0.5/c) + (0.2/d) + (0.2/e) + (0.1/f) + (0.4/g)

- Write a MATLAB program to implement Max-Min Composition

For Two Fuzzy sets
P = [0.3 0.7 ; 0.9 0.4 ; 0.2 0.5]

Q = [0.4 0.1 0.8;0.3 0.7 0.6]

- Implementation of Union, Intersection, Complement, XOR Operation and Demorgan's Law
- Write a MATLAB program to implement MAX Composition for the two set of Matrix

S = [0.3 0.7;0.9 0.4;0.2 0.5]
R = [0.4 0.1 0.8;0.3 0.7 0.6]

- Write a MATLAB program to implement Deffuzification of α-cut method
- For the following fuzzy set
- F = (0.6/a) + (0.3/b) + (0.7/c) + (1.0/d).

Project assigned by instructor to model real world problems.

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg.

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	2	-	3	1
CO2	2	3	2	2	-	-	-	-	1	-	3	1
CO3	2	3	2	2	1	-	-	-	1	-	3	1
CO4	3	3	3	2	2	-	-	-	2	-	3	1
Avg.	2.5	3	2.25	2	1.67	-	-	-	1.5	-	3	1

4th Year 7th Semester									
Sl No.	**Broad Category**	**category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG.	Major	BME701	Therapeutic Equipment	3	0	0	3	3
2	ENGG	Major	BME702	Medical Image Processing	3	0	0	3	3
3	ENGG	Major	BME703A	Hospital Engineering and Management	3	0	0	3	3
			BME703B	BioMEMs and Biomicrofluidics					
			BME703C	Drug Delivery System					
4	ENGG	Minor	EC(BME)704A	Laser and Optics in Healthcare	3	0	0	3	3
			EC(BME)704B	Medical Robotics and Automation					
			CS(BME)704C	Neural Network and Genetic Algorithm					
5	ENGG	Minor	CS(BME)705A	IOT and Telehealth Technology	3	0	0	3	3
			CS(BME)705B	Deep Learning and Machine Learning in Health Care					
			CS(BME)705C	Artificial Intelligence in Clinical Science					
B. Practical									
6	ENGG	Major	BME791	Therapeutic Equipment Lab	0	0	2	2	1
7	ENGG	Major	BME792	Medical Image Processing Lab	0	0	2	2	1
8	PRJ	Project	BME781	Major Project - I	0	0	6	6	3
9	PRJ	Internship	BME782	Industrial Training/ Internship	0	0	0	0	1
Total of Theory and Practical Courses								**25**	**21**

A. Theory

COURSE NAME: THERAPEUTIC EQUIPMENT
COURSE CODE: BME701
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: This course requires basic chemistry and physics, physiology, differential equations, control systems, bioinstrumentation knowledge.

Course Outcomes:

After completion of this course students will be able to

CO1: Integrate suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc.

CO2: Articulate the working principle of different types of therapeutic devices like pacemakers, defibrillators, ventilators, anaesthesia machine and surgical devices like electrosurgery unit.

CO3: Illustrate the application of lasers in biomedical applications.

CO4: Analyze the different types of therapeutic devices including paediatric applications and support.

Course Content:

Module- 1: Cardiac Pacemakers and Defibrillators 10L

Need for pacemaker, External pacemakers, implantable pacemakers and types; Programmable pacemakers; Codes for pacemakers; Pulse generator: sensing, output and timing circuits. Power sources, electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, Types of defibrillator electrodes, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, Implantable Cardioverter (ICD), RF ablation treatment for arrhythmia.

Module- 2: Ventilators and Anaesthetic System 7L

Basic principles of ventilators, Ventilators and types, different generators, inspiratory phase and expiratory phase, different ventillatory adjuncts, neonatal ventilators, p-based ventilator, ventilator testing. Anaesthesia: Need of anaesthesia, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.

Module- 3: Physiotherapy and Electrotherapy Equipment 7L

IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy; Electrotherapy and different waveforms, Electrode system, Electrical stimulators and types, Strength-duration curve, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulators, peripheral nerve stimulator, Ultrasonic stimulators, pain relief through electrical stimulators.

Module- 4: Surgical Diathermy and LASER 8L

Principles and applications of surgical diathermy, Electrosurgery machine, electrosurgery circuits, solid state electrosurgery generator circuits, electrosurgery safety, testing electrosurgery units, basic

principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO2, argon, He -Ne, Nd – YAG and pulsed ruby LASER, Application of LASER in surgery.

Module- 5: Patient Care and Assistive Systems **4L**

Baby incubator, radiant warmer and phototherapy unit. Suction apparatus, Infusion pumps, Peristaltic pumps, Implantable infusion pumps, Programmable volumetric pumps.

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. J.J. Carr and J.M. Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J. Webster, "Bioinstrumentation", Wiley and Sons.

Reference Books:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg., Boston.
2. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall, India
3. Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
4. Jacobson and Websler, "Medicine and Clinical Engg.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	-
CO3	3	3	-	-	-	2	2	-	-	-	-	2
CO4	3	3	-	-	2	-	2	-	-	-	-	2
Avg.	3	3	-	-	2	2	2	-	-	-	-	2

COURSE NAME: MEDICAL IMAGE PROCESSING
COURSE CODE: BME702
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

After completion of the course the students will be able to

CO1: Illustrate the significance and different application of medical image processing.

CO2: Apply knowledge of Mathematics and Signal Processing to solve Medical Image Processing related problems and achieve better results.

CO3: Analyze performance of different image processing technique in both spatial and frequency domains

CO4: Evaluate innovative medical image processing models using different techniques.

Course Content:

Module- 1: **8L**

Medical Imaging Fundamentals: **4L**

Image formation in human eye, Basic idea of images and medical images, Comparison of different imaging modalities, Mathematical and Logical operation of Medical Images.

Transform of Medical Images: **4L**

Importance of Medical Image Transform, Fourier Transform of Medical Image (DFT), Inverse Fourier Transform (IDFT), Fast Fourier Transform, Inverse Fast Fourier Transform, Applications of Medical Image Transform in different area.

Module- 2: **9L**

Medical Image Enhancement: **4L**

Importance of Medical Image enhancement, enhancement in spatial and frequency domain, Bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Medical Images, Frequency domain filtering in Medical Images– LPF, HPF and BPF.

Medical Image Compression: **5L**

Importance of Medical Image Compression, Types of Image Compression, Fidelity criteria, Lossless and Lossy compression, Compression in spatial domain (up and down sampling), compression using Huffman coding and compression using DPCM; DCT and Wavelet based medical image compression.

Module- 3: **10L**

Medical Image Restoration: **3L**

Importance of Medical Image Restoration, Reason for Image degradation, Inverse filtering, Weiner filtering.

Segmentation of Medical Images: **4L**

Importance of Medical Image Segmentation, Segmentation based on Region Growing, Clustering, Watershed algorithm, Otsu method, Application of different types of segmentation methods.

Edge detection in Medical Image Processing: 3L

Importance of Edge detection in Medical Image Processing, Types of Edge Detection, Mathematical Equation of each operator.

Module- 4: 9L

Color Models and Morphology: 3L

Color models in Images, Noise in color images. Concept of morphology in image processing, some basic morphological algorithms.

Medical Image Security: 3L

Water marking of medical images, Different Types of Watermarking, Introduction to Steganography and Cryptography used in medical images.

Algorithm used in Medical Image Processing: 3L

Importance of Medical Image Reconstruction, Tomography, Reconstruction using Fan Beam Projection and Parallel Beam Projection, Radon Transform, Medical Image Reconstruction in frequency Domain.

Text Books:

1. Digital Image Processing– R C Gonzalez and Woods – 3rd Edition
2. Digital Image Processing–S Sridhar
3. Digital Image Processing–S Jayaraman, T Veerakumar, S Esakkirajan
4. Fourier Optics and Computational Imaging –Kedar Khade

Reference Books:

1. Medical Image Processing-Concept and Application –Sinha, Patel
2. Digital Image Processing for Medical Applications–G Dougherty
3. Digital Image Processing–Jain

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	-	-	-	-	-	2
CO2	3	2	-	2	2	-	-	-	2	-	-	-
CO3	3	3	2	2	-	-	-	-	2	-	-	-
CO4	2	2	2	2	2	-	-	-	2	-	-	2
Avg.	2.5	2.5	2	2	2	-	-	-	2	-	-	2

COURSE NAME: HOSPITAL ENGINEERING AND MANAGEMENT
COURSE CODE: BME703A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Knowledge about biomedical instrumentation and various departments of hospital.

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain the basis of hospital classification, organizational hierarchy, management, and regulation of modern healthcare system.

CO2: Illustrate the workflow of various departments of the hospital and their responsibilities.

CO3: Integrate information management within the organization, connecting medical professionals and healthcare managers for technology planning, procurement and operation requirements.

CO4: Analyse efficient technology for safe use, considering the impact of technology on effective patient care with healthcare ethics.

Course content:

Module- 1: Healthcare System **4L**

Health organization of the country, Indian hospitals- challenges and strategies, modern techniques of hospital management.

Module- 2: Hospital Organization **9L**

Classification of hospital, Hospital- social system, location of hospital, site selection of new hospital, Line services, Supportive services and Auxiliary services of hospital.

Module- 3: Engineering Services of hospital **12L**

Biomedical engineer's role in hospital, Maintenance department, MRO, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system.

Module- 4: Hospital Management and Information System **7L**

Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system.

Module- 5: Regulation and planning of new hospital/Laboratory **4L**

FDA regulation, ISO certification, Fire protection standard, NABH, NABL

Text Books:

1. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 1993.
2. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z report Eschbom, 1986.

Reference Books:

1. Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press, 1977.
2. Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979.
3. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	3
CO2	3	3	-	-	-	-	-	-	-	-	-	3
CO3	3	3	3	2	3	-	-	3	-	-	-	3
CO4	3	3	3	2	3	3	2	3	-	-	-	3
Avg.	2.75	2.75	3	2	3	3	2	3				3

COURSE NAME: BIOMEMS AND BIOMICROFLUIDICS
COURSE CODE: BME703B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, Basics of sensors, Introduction to device Fabrication, Micro-fabrication Techniques, Fluid Mechanics.

Course Outcomes:

After completion of this course, students will be able to

CO1: Apply fundamental knowledge of micro-systems engineering including basic biological/ biochemical concepts and techniques emphasizing biomedical devices.

CO2: Illustrate material properties important for MEMS system performance; analyze dynamics of resonant micromechanical structures.

CO3: Design models using microfabrication technique and simulate electrostatic, electromagnetic sensors & actuators.

CO4: Evaluate the MEMs and microfluidics based analytical platform as per the requirement.

Course Content:

Module- 1: 7L

Introduction to BioMEMS and microfluidics, Introduction to Bio-Nanotechnology, Biosensors, fluidics. Introduction to device fabrication (Silicon and Polymers) Introduction to device fabrication (Silicon and Polymers). Sensors, Transduction and Performance factors. Sensors, Transduction and Performance factors continued.

Module- 2: 7L

Important materials for fabrication of BioMEMS Platforms. Introduction to silicon device fabrication Some Fabrication Methods for soft materials Transduction Methods. About cell potential and SHEs Cell reaction, Nernst equation, Construction of Ion selective electrodes Measurement and calibration of electrodes, ion-solvent interaction.

Module- 3: 10L

Introduction to Cell biology, Basic structure of DNA, DNA hybridization, DNA polymerization, PCR Thermal cycle, Real Time PCR.PCR design Electrophoresis, Gel and Capillary electrophoresis, Agarose DNA microarrays (concepts, and utility). Affymetrix and Nanogen approaches in realization of micro-arrays. DNA sequencing (Sanger's reaction). DNA nano-pores. DNA detection using Mechanical Cantilevers. Basics of Protein structure.

Module- 4: 12L

Protein charging at different pH range, Amino acids, protein polymerization, Transcription, Translation Antibody, Microencapsulation, Cyclic voltametry Microfluidics, Similarity of Streamlines, Pathlines, Sreaklines and Timelines for a steady flow Stress tensor. Viscosity, Newtonian, non-Newtonian fluids, Pseudoplastic, Dilatant, Bingham Plastic materials, Thixotropic

fluids. Flow over infinite plates, laminar and turbulent flow, Compressible and Incompressible flows. Flow over an infinite plate. Types of flows. Types of Fluids. Kinematics of fluids

Text/ Reference Books:

1. Introduction to BioMEMS, Albert Folch, CRC Press; 1st ed.
2. Essential Cell Biology, Bruce Albert, et al. Garland Science, 2nd ed.

3. **CO1:** Apply fundamental knowledge of micro-systems engineering including basic biological/ biochemical concepts and techniques emphasizing biomedical devices.
4. **CO2:** Analyze the material properties important for MEMS system performance and dynamics of resonant micromechanical structures.
5. **CO3:** Design models using microfabrication technique and simulate electrostatic, electromagnetic sensors & actuators.
6. **CO4:** Evaluate the MEMs and microfluidics based analytical platform as per the requirement.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	3	-	2	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2
CO3	3	2	3	-	2	-	2	-	2	-	-	2
CO4	3	3	3	-	2	-	-	-	2	-	-	2
Avg.	3	2.67	2.5	-	2	-	2.5	-	2	-	-	2

COURSE NAME: DRUG DELIVERY SYSTEM
COURSE CODE: BME703C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge on Polymers, Nanomaterials, Analytical chemistry

Course Outcomes:

After completion of this course, students will be able to:

CO1: Illustrate about drug delivery systems and its underlining considerations.

CO2: Select the basic criteria of drug and polymers for the development of drug delivery system.

CO3: Assess the critical considerations determining drug development and integrate the gained knowledge in developing new drug delivery systems.

CO4: Design the stable and optimized formulations for controlled/ sustained release and absorption of drugs.

Course Content:

Module- 1: Sustained Release (SR) and Controlled Release (CR) formulations 10L

Introduction and basic concepts, advantages/disadvantages, factors influencing, Physicochemical and biological approaches for SR/CR formulation, Mechanism of Drug Delivery from SR/CR formulation. Polymers: introduction, definition, classification, properties and application Dosage Forms for Personalized Medicine: Introduction, Definition, Pharmacogenetics, Categories of Patients for Personalized Medicines: Customized drug delivery systems, Bioelectronic Medicines, 3D printing of pharmaceuticals, Tele-pharmacy.

Module- 2: Rate Controlled Drug Delivery Systems 6L

Principles and Fundamentals, Types, Activation; Modulated Drug Delivery Systems; Mechanically activated, pH activated, Enzyme activated, and Osmotic Activated Drug Delivery Systems, Feedback regulated Drug Delivery Systems; Principles and Fundamentals.

Module- 3: Gastro-Retentive and Drug Delivery Systems 8L

Principle, concepts advantages and disadvantages, Modulation of GI transit time approaches to extend GI transit. Buccal Drug Delivery Systems: Principle of muco-adhesion, advantages and disadvantages, Mechanism of drug permeation, Methods of formulation and its evaluations.

Module- 4: Transdermal Drug Delivery Systems 4L

Structure of skin and barriers, Penetration enhancers, Transdermal Drug Delivery Systems, Formulation and evaluation.

Module- 5: Protein and Peptide Delivery 4L

Barriers for protein delivery. Formulation and Evaluation of delivery systems of proteins and other macromolecules.

Module- 6: Vaccine delivery systems **4L**

Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal delivery of vaccines.

Text Books:

1. Y W. Chien, Novel Drug Delivery Systems, 2nd edition, revised and expanded, Marcel Dekker, Inc., New York, 1992.
2. Robinson, J. R., Lee V. H. L, Controlled Drug Delivery Systems, Marcel Dekker, Inc., New York, 1992.

Reference Books:

1. Encyclopedia of controlled delivery, Editor- Edith Mathiowitz, published by Wiley Inter science Publication, John Wiley and Sons, Inc, New York, Chichester/Weinheim
2. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers and Distributors, New Delhi, First edition 1997 (reprint in 2001).
3. S.P. Vyas and R.K. Khar, Controlled Drug Delivery-concepts and advances, Vallabh Prakashan, New Delhi, First edition 2002.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	-	-	2	2	-	-	-	-	2
CO3	3	3	3	3	-	2	2	-	2	-	-	2
CO4	3	3	3	2	-	2	3	-	2	-	-	2
Avg.	3	2.75	2.5	2.33	-	2	2.33	-	2	-	-	2

COURSE NAME: LASER AND OPTICS IN HEALTHCARE
COURSE CODE: EC(BME)704A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Physics, Principle of LASER and Fiber Optics, Anatomy and physiology.

Course Outcomes:

After completion of this course, students will be able to:

CO1: Determine the basics and principles of Laser Operations.

CO2: Illustrate the construction of different laser system and their surgical application

CO3: Determine the various applications of Laser through various medical equipment.

CO4: Estimate the basic concepts of Optical fibers and their properties.

CO5: Illustrate the construction mechanism and selection criteria of Optical fiber bundles for imaging devices applying the light guided fundamentals and principles and outline the clinical applications of fiber optic Laser systems.

Course Content:

Module- 1: LASER Fundamentals 6L

Characteristics of lasers, spontaneous and stimulated emission of radiation, Einstein's co-efficient, Population Inversion, three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Cavity damping, Types of lasers: Gas lasers, solid lasers, liquid lasers, semiconductor lasers.

Module- 2: Laser Instrumentation 6L

Surgical instrumentation of CO2, Ruby, Nd-YAG, He-Ne, Argon ion, Q-switched operations, continuous wave, Quasi-continuous.

Module- 3: Laser applications 8L

Surgical applications: removal of tumors of vocal cords, brain surgery, plastic surgery, gynaecology and oncology. Lasers in tissue welding, lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, Laser flow cytometry, Laser transillumination and diaphanography, Speckle interferometry, holography, Application Safety with biomedical Lasers.

Module- 4: Optical Fibers Fundamentals 6L

Principles of light propagation through a fibre, Different types of fibers and their properties, fiber characteristic, transmission of signal in SI and GI fibers, attenuation in optical fibres, Connectors and splices, Fibre termination, Optical sources, Optical detectors.

Module- 5: Optical Fiber bundles and Clinical Applications 10L

Introduction and construction details of optical fibers, non-ordered fiber optic bundles for light guides-fundamentals and principles, ordered fiberoptic bundles for imaging devices-fundamentals and principles, fiberscopes and endoscopes fundamentals, fiber optic imaging systems-advances,

optical fiber in communication, fiber optic laser system in cardiovascular disease, Gynecology, neurosurgery, oncology, orthopedics, otolaryngology (ENT), urology.

Text Books:

1. Leon Goldman, "The Biomedical Laser Technology and Clinical Applications "Springer-Verlar.
2. BashtM.L.Wel, "Laser applications in medicine and biology", Vol I,II,III, Plenum Press (1971 and 1974).
3. J. Wilson and J.F.B. Hawkes, „Introduction to Opto Electronics", Prentice Hall of India, 2nd Edition,2001.
4. S.L.Wymer, Elements of fiber optics, Regents PHI

Reference Books:

1. Ronal W. Waynant, Lasers in Medicine, CRC Press, 2002.
2. Pratesi E.D.R, and Sacchi, "Lasers in photomedicine and photo biology", Springer-Verlay
3. Nandini K. Jog, "Electronics in medicine and biomedical instrumentation", PHI.
4. J.M. Senior, "Optical Fiber Communication – Principles and Practice", Prentice Hall of India,1st edition,1985.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	2	-	2	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	2	2	2	-	-	-	2
Avg.	3	2.5	2	-	-	2	2	2	-	-	-	2

COURSE NAME: MEDICAL ROBOTICS AND AUTOMATION
COURSE CODE: EC(BME)704B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Knowledge of Electronics, Sensors, Mechanics and Control.

Course outcomes:

After completion of the course, students will be able to

CO1: Understand the basics of Robotics- its configuration and applications.

CO2: Apply the knowledge to identify and describe different types of medical robots and their potential applications

CO3: Acquire the basic concepts in kinematics, dynamics and control relevant to medical robotics along with various roles that robotics can play in healthcare.

CO4: Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.

Course Content:

Module- 1: Introduction of Robotics **7L**

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine

Module- 2: Actuators and Grippers **7L**

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models

Module- 3: Manipulators and Basic Kinematics **6L**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Module- 4: Power Sources and Sensors **8L**

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging – Laser- Acoustic, Magnetic fiber optic and Tactile sensor.

Module- 5: Robotics in Medicine **8L**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

Text Books:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.

Reference Books:

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005.
2. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw-Hill, First Edition, 1983.
3. Jacob Rosen, Blake Hannaford and Richard M Satava, “Surgical Robotics: System Applications and Visions”, Springer 2011.
4. Barbara Webb and Thomas R Consi, “BioRobotics: Methods and Applications”, Barbara Webb and Thomas R Consi, AAAI Press/MIT Press, First Edition, 2001.
5. Constantinos Mavroidis, Antoine Ferreira, “Nanorobotics: Current approaches and Techniques”, Springer 2011

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	2	-	-	-	2	-	-
CO2	3	3	2	3	2	2	2	2	-	1	1	2
CO3	3	2	2	2	2	1	-	-	2	-	-	1
CO4	3	3	3	3	3	2	2	3	2	-	2	2
Avg.	3	2.5	2.25	2.5	2.33	1.75	2	2.5	2	1.5	1.5	1.67

COURSE NAME: NEURAL NETWORK AND GENETIC ALGORITHM
COURSE CODE: CS(BME)704C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge on Calculus, Linear Algebra, Statistics, Probability and Programming.

Course Outcomes:

After completing the course, the students will be able to

CO1: Model Neuron and Neural Network, and to analyze ANN learning, and its applications.

CO2: Perform Pattern Recognition, Linear classification and Develop different single layer/multiple layer Perception learning algorithms.

CO3: Understand about the Genetic Algorithm and explain clearly how crossover, mutation and selection operators work.

CO4: Identify problem types which might require GAs to find a solution.

Course Content:

Module- 1: Neural Networks **10L**

Definition of Neural Network, Learning rules and various activation functions, Encoding (training phase) and decoding (active phase), Single layer Perceptions, Back Propagation networks, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications. Taxonomy of neural networks: feed forward and recurrent networks with supervised and unsupervised learning laws, static anddynamic processing systems, basic data structures: mapping of vector spaces, clusters, principal components.

Module-2: Linear Networks **8L**

Adaline - the adaptive linear element, Linear regression. The Wiener-Hopfequation. The Least-Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back-Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Net talk.

Module-3: Feedback neural networks **3L**

Pattern storage and retrieval, Hopfield model, Boltzmann machine, Recurrent neural networks.

Module- 4: Fundamentals of Genetic Algorithm: **11L**

A brief history of evolutionary computation, biological terminology, search space encoding, reproduction elements of genetic algorithm, genetic modeling, comparison of GA and traditional search methods. Genetic technology: steady state algorithm, fitness scaling, inversion. Genetic programming: Genetic Algorithm in problem solving, Implementing a Genetic Algorithm: computer implementation, operator (reproduction, crossover and Mutation, Fitness Scaling, Coding,

Discretization). Knowledge based techniques in Genetic Algorithm. Advanced operators and techniques in genetic search: Dominance, Diploidy and Abeyance. Inversion and other reordering operators, Niche and speciation.

Module-5: Applications of Genetic Algorithm **4L**

Genetic Algorithm in engineering and optimization-natural evolution –Simulated annealing and Tabu search -Genetic Algorithm in scientific models and theoretical foundations.

Text/ Reference Books:

1. Goldberg, Genetic Algorithms, Addison Wesley, 1989, ISBN 0-201-15767-5
2. Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1998, ISBN 0-262-63185-7

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	2	-	-	-	2	-
CO2	3	3	3	2	2	2	2	-	2	-	-	2
CO3	3	2	-	1	2	-	-	-	2	2	-	-
CO4	3	2	3	2	1	2	-	-	-	-	-	3
Avg.	3	2.25	3	2	1.75	2	2	-	2	2	2	2.5

COURSE NAME: IOT AND TELEHEALTH TECHNOLOGY
COURSE CODE: CS(BME)705A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic programming knowledge

Course Outcomes:

On completion of this course, the students shall be able to

CO1: Ascent the basic concepts of IOT in healthcare.

CO2: Correlate the existing hardware platforms and sensor interfaces for various healthcare-based Applications.

CO3: Comprehend the ways of communication between the client and the server in IOT.

CO4: Enumerate the various services available in IOT.

CO5: Build various applications in healthcare using IOT based approach and substantiate the same with appropriate case studies.

Course Content:

Module-1: IOT: An Introduction **12L**

Introduction to Embedded Systems-an overview, features. Networked Embedded System types and overview, wireless communication standards-zigbee, Bluetooth and Wi-Fi. OSI and TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. IOT- understand what IOT is and discuss its application in health-care systems-Patient Monitoring and diagnostics, home healthcare and Personal care and Fitness.

Module-2: IOT Hardware Platform and Sensor Interface **8L**

Introduction to CC3100 Wi-Fi Booster Pack: overview and features. Introduction to CC3100 SDK: understand the important APIs. Getting Started with Energia Wi-Fi libraries. Sensor interface: Temperature sensor, pressure sensor, Light sensor, IR sensor.

Module- 3: Client-Server Communication Paradigm **5L**

Basic Client-Server communication model, Network Sockets, Ports, and Examples of client server communication, Energia client and server class APIs.

Module- 4: Embedded Web-Server and IOT Cloud Services **6L**

Embedded web server: Basic introduction, its importance and role in IOT, Design of a simple embedded web server: understand the HTTP and HTML basics Overview of different IOT Cloud Services.

Module- 5: Application Design and Case Study **5L**

Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration,

Case Study1: Wireless Patient Monitor system

Case Study2: Wearable Fitness and Activity Monitor

Text/ Reference Books:

1. Getting Started with Internet of Things- CunoPfister, 2011
2. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**-**	**-**	**-**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
CO4	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO5	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
Avg.	**2.4**	**-**	**2.33**	**-**	**2**	**2.5**	**2**	**-**	**-**	**2.5**	**-**	**2.5**

COURSE NAME: DEEP LEARNING AND MACHINE LEARNING IN HEALTH CARE
COURSE CODE: CS(BME)705B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic programming skills, Algorithm design, Probability, Linear Algebra, Optimization, Statistics, Calculus.

Course Outcomes:

After completion of this course students will be able to

CO1: Integrate the basic concepts of Deep Learning and Machine Learning and their applications in medical field.

CO2: Design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.

CO3: Explore supervised and unsupervised learning paradigms of machine learning and various feature extraction strategies of Deep learning technique

CO4: Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Course Content:

Module 1: Introduction to Deep Learning 6L

Definition and importance of Deep Learning, Binary Classification, Logistic Regression, Logistic Regression Cost Function, Gradient Descent, Derivatives, Computation Graph.

Module- 2: Deep Learning for Healthcare 10L

Introduction, Machine learning basics, Health data, Deep Neural Networks (DNN), Embedding, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Autoencoders, Attention Models, Graph Neural Networks, Memory network, Deep generative models.

Module- 3: Fundamentals of Machine Learning 8L

Definition, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Machine Learning algorithms and Model Selection, Sparse Modeling and Estimation, Scalable Machine Learning (Online and Distributed Learning), Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Module- 4: Machine Learning for Healthcare 12L

Overview of Clinical Care, Deep Dive into Clinical Data, Risk Stratification, Survival Modelling, learning from Noisy Labels, Detecting and Mitigating Dataset Shift, Machine Learning for Pathology, Machine Learning for Mammography, Physiological Time-Series, Differential Diagnosis, Precision Medicine, Disease Progression Modelling and Subtyping

Text Books

1. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer; 1st ed. 2018 edition
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", published by MIT Press
3. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer

Reference Books:

1. Francois Chollet, "Deep Learning with Python", Manning Publications; 1st edition
2. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
4. Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	-	-	-	-	-	-	2
CO2	3	2	3	2	2	2	-	-	-	-	-	2
CO3	3	2	3	3	2	-	-	-	-	-	-	2
CO4	3	2	2	2	1	2	-	-	-	-	-	-
Avg.	3	2	2.5	2.25	1.75	2	-	-	-	-	-	2

COURSE NAME: ARTIFICIAL INTELLIGENCE IN CLINICAL SCIENCE
COURSE CODE: CS(BME)705C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: A basic knowledge in linear algebra, discrete mathematics, probability and statistics and data structures.

Course Outcomes:

At the end of this course, each trainee/student will be able to

CO1: Understand models of human and artificial intelligence, specifically computational models of intelligence.

CO2: Identify and apply appropriate intelligent system models and computational tools to specific problems in biomedicine and healthcare.

CO3: Analyze the performance of specific models as applied to biomedical problems, and justify their use and limitations.

CO4: Identify, understand, and interpret methods and evidence from artificial intelligence and other relevant literature.

CO5: Effectively communicate and disseminate knowledge in any science or engineering domain in the context of computing, systems, and/or biomedical applications.

Course Content:

Module- 1: Foundations **20L**

Introduction to Human and Artificial Intelligence: terminologies, computational models of intelligence; conceptual frameworks from cognitive and educational psychology, neuroscience, information theory, and linguistics; philosophical foundations of AI; Review of relevant mathematical and statistical concepts: logarithmic loss, cross entropy optimizing cost functions; linear and logistic regression; Forms of Learning: supervised, semi-supervised, unsupervised, active, and transfer learning; Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning: neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks; Unsupervised Learning: basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction); Knowledge Representation and Reasoning: Prepositional logic, first-order logic, ontological engineering, probabilistic reasoning; Time-series analysis: temporal models (probabilistic reasoning over time); Emerging paradigms and concepts in artificial social and emotional intelligence

Module- 2: Applications **10L**

Unique characteristics and challenges in medicine and healthcare; History and status quo of intelligent and expert systems in medicine; Risk stratification, patient outcome prediction, disease progression modeling; Clinical decision-making and intelligent systems to support evidence-based medicine; Phenotype and clinical/bio-marker discovery, Relevance to personalized medicine; Analysis of tissue morphology and other medical imaging applications

Module- 3: Implementation and Evaluation **6L**

Tools and Technologies for implementing AI methods; Model evaluation and performance metrics, cross-validation, model interpretability; Ethics of AI: bias, fairness, accountability, and transparency in machine learning; Ethical, Legal, and Social Issues of AI in medicine and healthcare.

Text/ Reference Books:

1. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
2. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
3. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer.
4. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
5. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**2**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**2**
Avg.	**3**	**1.8**	**2.5**	**2**	**1.75**	**2**	**-**	**-**	**-**	**3**	**-**	**2**

B. Practical

COURSE NAME: THERAPEUTIC EQUIPMENT LAB
COURSE CODE: BME791
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Basic knowledge of Biomedical Instrumentation.

Course Outcomes:

After completion of the course the students will be to

CO1: Articulate different types of medical equipment and demonstrate the measuring of basic medical parameters.

CO2: Illustrate the working principle of versatile medical equipment.

CO3: Perform the monitoring of basic medical parameters.

CO4: Recommend problem solving and service procedures for electrical equipment and apply safety standards and procedures for medical equipment.

List of experiments:

1. Study on simulated DC defibrillator
2. Study on muscle stimulator
3. Study on ECG heart rate monitor with alarm system
4. Study on peripheral pulse rate monitor with alarm system
5. Study on digital body/skin temperature monitoring system
6. Study on hearing aid and audiometer: air and bone conduction
7. Study on Nerve Conduction Velocity measuring system
8. Study on EMG biofeedback system
9. Study on ECG simulator and servicing of ECG machine
10. Study on US Doppler / Fetal monitor
11. Innovative experiment

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	2	-	2
CO2	3	3	-	-	3	2	2	-	-	-	-	-
CO3	3	3	-	2	3	2	2		3	-	-	2
CO4	3	3	2	-	-	2	2	-	3	2	2	2
Avg.	3	3	2	2	3	2	2	-	3	2	2	2

COURSE NAME: MEDICAL IMAGE PROCESSING LAB
COURSE CODE: BME792
CONTACT: 0:0:2
CREDITS: 1

Prerequisite: Digital Signal Processing

Course Outcomes:

After completion of the course the students will be able to

CO1: Explain the significance and different applications of image processing in healthcare.

CO2: Apply different image processing techniques in medical images to achieve better results.

CO3: Analyse the various medical image processing algorithms; appraise efficacy and drawbacks of several techniques.

CO4: Design innovative medical image processing models using different techniques.

List of Experiments:

1. Convert multiple RGB Medical Images into Grey Scale Images, change the brightness-contrast and show the different planes of the images.
2. Perform the logical operation on images and also perform encryption with colour plane or logical operation concept.
3. Display histogram of a medical image and perform histogram processing operations for the image.
4. Apply Mean and Median filtering in a grayscale medical image and display the result.
5. Transform a grayscale image into frequency domain and show its magnitude and phase-angle.
6. Apply LPF and HPF in a grey scales medical Image and displays the result.
7. Compress and reconstruct a RGB and Grey scale image in spatial domain.
8. Compress and reconstruct a Grey Scale Medical Image in frequency domain.
9. Apply segmentation technique (any one) in a medical image and display the result.
10. Apply edge detection technique in a medical image and display the result.
11. Apply any cryptography technique for image encryption and show the output.
12. Innovative experiment

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	-	-	2	-	-	2
CO2	3	3	2	-	2	-	-	-	-	-	-	-
CO3	3	3	3	2	2	-	-	-	2	-	-	2
CO4	-	-	3	2	3	-	-	-	2	-	-	-
Avg.	2.67	3	2.5	2	2.25	-	-	-	2	-	-	2

4th Year 8th Semester									
Sl No.	Broad Category	category	Paper Code	Subject	Contact Hours/Week				Credit Points
					L	T	P	Total	
A. Theory									
1	ENGG	Major	BME801	Artificial Organs and Rehabilitation Engineering	3	0	0	3	3
2	ENGG	Major	BME802	Modelling of Physiological System	3	0	0	3	3
3	ENGG	Major	BME803A	Biomedical Hazards and Safety	3	0	0	3	3
			BME803B	Radiotherapy and Nuclear Medicine					
			BME803C	Troubleshooting and Maintenance of Medical Equipment					
4	ENGG	Major	BME804A	Biological Control System	3	0	0	3	3
			BME804B	Computational Biology					
			BME804C	Quality Assurance and Regulatory Aspects of Medical Equipment					
B. Practical									
5	PRJ	Project	BME881	Major Project - II	0	0	12	12	6
6	ENGG	Major	BME882	Grand Viva	0	0	0	0	1
Total of Theory and Practical Courses								**24**	**19**

A. Theory

COURSE NAME: ARTIFICIAL ORGANS AND REHABILITATION ENGINEERING
COURSE CODE: BME801
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of Engineering Physiology, Anatomy, Biomaterials & Biomechanics.

Course Outcomes:
After completion of this course students will be able to

CO1: Determine various types of host tissue response with respect to different biomaterials used for fabrication of artificial organ & prosthesis.

CO2: Apply knowledge to explain the working principles and design concept of various artificial organ and extracorporeal devices used as prosthesis or rehabilitation purposes.

CO3: Correlate the problem or abnormality in physiological system and the performance measurement of the corresponding artificial organ.

CO4: Implement the necessary skills required for effective solution in terms of rehabilitation engineering with respect to different impairments & disabilities.

Course Content:

Module- 1: Introduction to Artificial Organ 6L

Introduction, Substitutive medicine, Clinical problems requiring implants for solution, outlook for organ replacement, design consideration, Biomaterials used in artificial organs and prosthesis, Inflammation-Rejection-Correction.

Module- 2: Artificial Kidney 10L

Kidney Filtration and Basic methods of waste removal, Hemodialysis, Equation for artificial kidney and middle molecule hypothesis, Different types of Hemodialyzers (Flat-Plate, Coil Type and Hollow Fiber Type), Analysis of mass transfer in dialyzers (cross current and counter current flow), regeneration of dialysate, Wearable Artificial Kidney Machine.

Module- 3: Artificial Heart-Lung Machine and Liver Support System 6L

Brief of lungs gaseous exchange, Artificial heart-lung device, different types of Oxygenators (bubble, film, membrane).

Artificial Pancreas; Artificial Blood and Artificial Skin

Module- 4: Audiometry 4L

Air and Bone Conduction, Masking, Functional Diagram of Audiometer, Different types of Hearing Aids; IABP Principle and application.

Module- 5: Rehabilitation Engineering **10L**

Measurement and Assessment of Impairments, Disabilities and Handicaps, Engineering concepts in communication disorders, sensory and motor rehabilitation. Rehabs for locomotion, visual, speech and hearing, Artificial Limb, Prosthetic Heart Valve, Myo-electric Hand and Arm Prosthesis, MARCUS Intelligent Hand Prosthesis, Spinal rehabilitation. Ethical, economical, environmental and legal aspects in artificial organs domain.

Text Books:

1. Handbook of Biomedical Engineering. Bronzino Joseph.
2. Handbook of Biomedical Instrumentation. R.S. Khandpur, TMH.
3. Artificial Organs. Erie.D. Blom, Howard.B. Rotham.

Reference Books:

1. Biomedical Engineering Principles (Volume-II). David O.Cooney.,Marcel Dekker Inc.
2. Rehabilitation Engineering. Robbinson C.J., CRC press1995.
3. Rehabilitation Engineering. IOS press1993.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**2**	**-**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**2**
Avg.	**3**	**3**	**2**	**-**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**2**

COURSE NAME: MODELLING OF PHYSIOLOGICAL SYSTEM
COURSE CODE: BME802
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Human anatomy and physiology, Control system and analysis, Physics, Higher Engineering Mathematics

Course Outcomes:

After completion of the course the students will be able to

CO1: Illustrate the requirements for the development of mathematical and computational models in the analysis of physiological process/ biological systems.

CO2: Select and apply appropriate analytical and numerical tools to solve ordinary differential equation models of biological problems.

CO3: Interpret the biological significance of linear and nonlinear control systems.

CO4: Integrate electrical, electrochemical, physiological and mechanical phenomena into the design of models to assess their inter-dependencies.

CO5: Break down a complex physiological system into the function of its component subsystems, and then build an engineering model based on subsystems.

Course Content:

Module- 1: Basic Concepts of Physiological System 8L

Introduction to physiological system and mathematical modelling of physiological system, the techniques of mathematical modelling, classification of models-black box and building block, parametric and non-parametric, lumped and distributed models, linear and non-linear, characteristics of models, Purpose of physiological modelling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables and properties- Resistance, Compliance and their analogy. Time invariant and time varying systems for physiological modelling.

Module- 2: Equivalent Circuit Model 8L

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.

Module- 3: Linear Model 4L

Respiratory mechanics and muscle mechanics, Huxley model of isotonic muscle contraction, modelling of EMG, motor unit firing: amplitude measurement, motor unit and frequency analysis.

Module- 4: Modelling of Blood flow and Urine formation 5L

Electrical analogue 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.

Module- 5: Linearized model of the immune response **3L**

Germ, Plasma cell, Antibody, system equation and stability criteria.

Module- 6: Cardio-Pulmonary Modelling **4L**

Cardiovascular system and pulmonary mechanics modelling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms.

Module- 7: Eye Movement Model **4L**

Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model.

Text Books:

1. Endarle, Blanchard and Bronzino, Introduction to Biomedical Engg., Academic press.
2. Suresh. R. Devasahayam, Signals and Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.
3. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.
4. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.
5. L.Stark, Neurological Control System, Plenum Press.
6. R.B. Stein, Nerve and Muscle, Plenum Press.

Reference Books:

1. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001.
2. Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rdedition, 2006.
3. Christof Koch, "Biophysics of Computation", Oxford University Press, 28-Oct-2004.
4. Modeling and Simulation in Medicine and the Life Sciences (2nd Edition), by F.C. Hoppensteadt and C.S. Peskin, Springer (2002) ISBN: 0-387-95072-9.
5. John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan and Claypool Publishers, 2010.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2
CO2	3	2	2	2	3	2	2	-	-	-	-	1
CO3	3	2	2	3	-	-	-	-	-	-	-	1
CO4	3	2	3	2	2	2	-	-	-	-	-	-
CO5	3	2	3	2	2	1	2	-	-	-	-	2
Avg.	3	2.2	2.6	2.2	2.25	1.67	2					1.5

COURSE NAME: BIOMEDICAL HAZARDS AND SAFETY
COURSE CODE: BME803A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Knowledge of biomedical instrumentation and hospital management

Course outcome:

After completion of the course the students will be able to

CO1: Demonstrate the types of hazards, planning, organization and training needed to work safely with hazardous materials.

CO2: Explain the different types of hazardous exposure and its biological effects, exposure guidelines and basic workplace monitoring.

CO3: Understand the policies, safety standards in compliance with regulatory requirements and within engineering limits.

CO4: Apply knowledge to prevent workplace injury, risk management and also for safety record keeping and management.

Course Content:

Module- 1: Electrical & Fire Safety 7L

Electrical Hazards, Causes of Electrical Shock, Effect of Shocks, Macro & Micro shocks -Hazards, monitoring and interrupting the Operation from leakage current, Use of Isolation amplifier, Safety precautions for electrical hazards; Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital.

Module- 2: Laser and Ultraviolet Radiation Safety 7L

Classification of UV radiation, Sources of UV, Biological effects of UV radiation, UV control measures, Safety management of UV. Classifications of LASER and its radiation hazards- control measures, Emergencies and incident procedures.

Module- 3: Hospital Safety 7L

Security & Safety of Hospital -Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Ethics and Safety measures on Disposal of healthcare waste.

Module- 4: Standardization of Quality Medical Care in Hospitals 6L

Define Quality- Need for Standardization & Quality Management**,** TQM in Health care organization- Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment, Medical device safety and risk management, Effectiveness/performance of medical devices, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance.

Module- 5: Assessing Quality Health Care 4L

Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of

hospital services – six sigma way, Quality Assurance in Hospitals SOPs – Patient Orientation for Total Patient Satisfaction. 5S techniques.

Module- 6: Regulatory Requirement for Health Care 5L

FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, National Guidelines for Infection Prevention and Control in Healthcare Facilities, Health protocol guidelines on unforced emerging issues, Other regulatory Codes.

Text Books:

1. Khandpur R.S., Hand book of Biomedical instrumentation, TMH
2. Carr & Brown, Introduction to Biomedical Equipment, PHI
3. Webster J. G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy,1979.
4. Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York,1977.

Reference Books:

1. B. M. Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P)Ltd.
2. K. Shridhara Bhat, Quality Management, Himalaya PublishingHouse.
3. Karen Parsley, Karen Parsley Philomena Corrigan‖ Quality improvement in Healthcare, 2nd edition, Nelson Thrones Pub, 2002
4. Sharon Myers ―Patient Safety & Hospital Accreditation - A Model for Ensuring Success‖ Springer Publishers 2012
5. Joseph F Dyro ―Clinical Engineering Handbook― Elsevier Publishers,2004

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**3**	**3**	**2**	**2**	**-**	**-**	**2**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**-**	**-**
CO3	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**2**	**-**	**-**
CO4	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**3**	**-**	**-**	**-**
Avg.	**3**	**1.67**	**-**	**-**	**-**	**3**	**2.5**	**2.33**	**2.33**	**2**	**-**	**2**

COURSE NAME: RADIOTHERAPY AND NUCLEAR MEDICINE
COURSE CODE: BME803B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basics of Physics, Advanced Medical Imaging.

Course Outcomes:
After completion of this course students will be able to

CO1: Understand the utility of Radiotherapy and Nuclear Medicine in healthcare system.

CO2: Analyze the various safety measures for radiation protection in concerned department and environment.

CO3: Apply the concept of radiation detection and measurement for measuring the limit of radiation exposure and applications of various radiation detectors.

CO4: Develop knowledge and practical skills related to functioning of different equipment for radiotherapy and in clinical nuclear medicine.

Course Content:

Module- 1: Introduction 5L

Physical aspects of radiation therapy, radiotherapy treatment planning, Radiation sources and their properties, Radiotherapy equipment, Radiotherapy Techniques, Radiation protection, Side effects on Biological System, Safety measures.

Module- 2: Radiation Chemistry 8L

Characteristicsandbehaviorofradioactivetracersinbiologicalprocess-(Physical and Biological), Absorption of radiation, Survival curves-theory, Oxygen effect, Chemical modifiers of radiation damage, Cell cycle dependence of radio sensitivity, Repair phenomena, Solid tumor radiobiology, Cell and tumor kinetics, Tissue radio sensitivity, Dose Rate effects, Acute and late effects, Partial and Whole-Body Radiation, Time, Dose and Fractionation relationships, Biology of Hyperthermia.

Module- 3: Radiation Detectors 7L

Construction and Principles of Operation of Ionization Chamber, Isotope calibrator, Proportional Counter, Geiger Muller counter, Voltage calibration of a Geiger Mueller tube, optimum operating condition–Dead time correction–Uses of Gas filled detectors, Semiconductor detectors, Scintillation detectors.

Module- 4: Radioactivity 8L

Natural and artificial radioactivity, alpha decay, beta decay and gamma emission, positron decay, exponential decay, half-life, unit of activity, Radiation sources- natural and artificial, Production of radioisotopes. Nuclear reactors, Cyclotron Unit, Linac, Fission products, Gamma ray source for medical uses.

Module- 5: Nuclear Medicine Procedure and its applications in biomedical field 8L

Basics of nuclear medicine, Design and description of NM department, NM equipment, Nuclear

medicine procedure- PET, SPECT etc., Some common uses of nuclear medicine procedure, benefits and risks of nuclear medicine procedure, limitations of nuclear medicine, examples of general nuclear medicines,

Scintigraphy, Bone scintigraphy, RIA and ELISA techniques and their applications, Tracer dose, Uptake monitoring instruments.

Text Books:

1. Meredith, Fundamental Physics of Radiology
2. Faiz M Khan, The physics of Radiation Therapy, Edition 4th
3. Hall E J, Radiobiology for the Radiologist, 6th Edition.
4. Physics of Nuclear Medicine, -James A. Sorenson and Michael
5. Principles and practice of Nuclear Medicine, Bruce Sodee, Paul J. Early and Sharon Wikepry

Reference Books:

1. Nuclear Radiation Detection –William J. Price, McGraw –Hill Book Company.
2. Principles of Nuclear Medicine –Henry N. Wagner, W.B. Saunders company, London.
3. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton J W B Saunders company, London.
4. Clinical Nuclear Medicine M N Masey, K E Britton and D L Gilday, Chapman and Hall medicals.
5. Nuclear Medicine Technology and Techniques- Donald R. Bernier, Paul E. Christian and James K. Langan Mosby.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**											
CO2	**3**											
CO3	**3**					**2**	**2**	**2**				
CO4		**3**		**2**							**2**	**2**
Avg.	**3**	**3**		**2**		**2**	**2**	**2**			**2**	**2**

COURSE NAME: TROUBLESHOOTING AND MAINTENANCE OF MEDICAL EQUIPMENT
COURSE CODE: BME803C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basics of Biomedical Instrumentation and Different types of Medical Equipment.

Course Outcomes:

After completion of this course student will be able to

CO1: Understand the basic design processes of medical device.

CO2: Analyze the various construction and development protocol of medical devices.

CO3: Apply the concept of safe device applications and fault findings.

CO4: Develop knowledge and practical skills related to troubleshooting, maintenance and repairing of medical instruments.

Course Content:

Module- 1: **5L**

Fundamentals of Medical Instrumentation: Bioelectric Signals and Physiological Transducers. Related Anatomy and Physiology.

Operation, functional circuit details: Patient Safety, Repair, Service and Maintenance of a range of medical equipment.

Module- 2: **8L**

Mechanical Equipment: BP Apparatus, Suction Machine and Microscope.

Recording and Monitoring Equipment: ECG and EEG Machines, Pulse, Oximeter, Cardiac Monitor and Audiometer.

Module- 3: **7L**

Clinical Lab and Imaging Systems Equipment: Colorimeter, Spectrophotometer, Semi-Auto Analyzer, Centrifuge and Oven. X-Ray and Ultrasound Machines.

Module- 4: **7L**

Therapeutic Equipment: Cardiac Defibrillator, Short wave and Ultrasonic Diathermy. Anesthesia Machine.

Module- 5: **8L**

Maintenance of pc based medical equipment: Introduction to - System configuration and BIOS, Identificationand Troubleshooting of PC components viz-Motherboard, HDD, FDD, CD ROM, Monitor, Printers, Modems, Ports etc. Installation and operation of - Windows Operating System, Antivirus Software, Internetworking.

Text Books:

1. R. S. Khandpur, Biomedical Instrumentation Technology and Applications, McGraw-Hill Professional, 2004 (UNIT I, II)
2. Raja Rao, C; Guha, S.K, Principles of Medical Electronics and Biomedical Instrumentation, Orient Longman Publishers (2000) (UNIT III, IV and V)

Reference Books:

1. R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009.
2. John G. Webster, Medical Instrumentation: Application and Design, 3rd edition, John Wiley and Sons, New York, 1998.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	1	-	-	-	-	-	-	-
CO2	2	3	3	3	2	-	2	-	-	-	-	1
CO3	1	2	2	-	2	2	1	1	-	-	-	1
CO4	1	2	2	2	1	-	-	2	-	-	-	2
Avg.	1.75	2.5	2.25	2.5	1.5	2	1.5	1.5	-	-	-	1.33

COURSE NAME: BIOLOGICAL CONTROL SYSTEM
COURSE CODE: BME804A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Fundamentals of control system.

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain the basic concept of Engineering and Biological Control System along with related mathematical approaches.

CO2: Categorize the different biological process regulations and biological control processes for suitable conclusion.

CO3: Correlate the resemblance and difference among various Biological Control Systems and Engineering Control Systems to meet the healthcare need.

CO4: Illustrate the reasons for deviance from normal physiology and biological process regulations to restore homeostasis.

Course Content:

Module- 1: Introduction 14L

Technological Control System, Mathematical approaches, System stability, Differences and similarities between biological and engineering control system, Generalized System Properties, Root Locus Plots, Routh–Hurwitz (RH) Stability Criterion, Linear and Non-linear systems, Time invariant and time varying systems of biological control processes, Linear model of respiratory mechanics, Linear model of muscle mechanics. “Systems Physiology” Versus “Systems Biology”.

Module- 2: Process regulation: 8L

Acid – base balance, Extra cellular water and electrolyte balance, Interstitial fluid volume, Blood pressure, Blood glucose, Thermal regulatory system.

Module- 3: Biological Control 14L

Cardiac rate, Respiratory rate, Mass balancing of lungs, Oxygen uptake by RBC and pulmonary capillaries, Oxygen and carbon dioxide transport in blood and tissues, Urine formation and control, skeletal muscle servo mechanism and semi-circular canal, Adaptive characteristics of the muscle stretch reflex, Block diagram representation of the muscle stretch reflex, physiological control systems: muscle stretch reflex, Model of obstructive sleep apnea–chemoreflex interaction in ventilatory control, Endocrine control system.

Text Books:

1. Ogata Katsuhika, Modern Control Engineering. 2nd Edition, Prentice Hall of India.
2. Ibrell and Guyton, Regulation and control in physiological system.

Reference Books:

1. Milsum Jhon H., Biological control system analysis, Tata McGraw-Hill.
2. Milhom T.H. Saunder. Application of control theory to physiological systems, The University of Chicago Press.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO4	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
Avg.	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.5**

COURSE NAME: COMPUTATIONAL BIOLOGY
COURSE CODE: BME804B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of Biomolecules, Molecular Biology and Organic Chemistry.

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply knowledge for designing biomolecular structures and their engineering aspects.

CO2: Design atomic level molecular modeling for complex biomolecular structures.

CO3: Analyze various techniques to develop the structural macromolecular properties.

CO4: Utilize research base knowledge for modeling and designing of macromolecular complex.

Course Content:

Module- 1: Biomolecules 15L

Biomolecular Structure and their Hierarchy, Amino acids, protein polymerization, Transcription, Translation, Antibody, Protein charging at different pH range, Homology Modeling, Molecular Docking of Peptide and Protein Receptors, Microencapsulation, Cyclic voltametry Microfluidics, Similarity of Streamlines, Pathlines, Sreaklines and Timelines for a steady flow Stress tensor.

Module- 2: Applications of Molecular Quantum Mechanics 12L

Discrete Solvation Models in Molecular Mechanics and Statistics, Continuum Solvation Models in Molecular Mechanics and Statistics, The Perspective of Quantum Mechanics, Continuum Solvation Models in Quantum Mechanics, The Mean–Field in Action, The Solid-State Approach, The Super–Cell in Action, Metal Ions and Protons compete, Water and Amino acids Compete for the Same Metal Ion.

Module- 3: Molecular Dynamics 9L

Tutorial from GROMACS Tutorial: Lysozyme in Water, Umbrella Sampling, Biphasic System, Protein Ligand System, Free Energy of Solvation, Virtual sites. Molecular Simulation.

Text Books:

1. Chemistry of Biomolecules, 2nd Edition, S.P. Bhutani, CRC Press.
2. Biomolecules, N. Arumugam, Saras Publication.
3. Molecular Modeling and Simulation, Tamar Schlick, Springer, NY.

Reference Books:

1. Biomolecular Simulations: Methods and Protocols, Luca Monticelli, Emppu Salonen, Springer, NY.
2. Innovations in Biomolecular Modeling and Simulations: Volume 2, Tamar Schlick, RSC Publishing.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	1	-	-	-	-	1	1
CO2	1	2	3	-	2	-	2	2	-	1	2	1
CO3	-	2	3	2	3	2	-	-	2	-	2	2
CO4	2	3	3	2	1	1	2	1	3	2	3	3
Avg.	2	2.5	2.75	1.67	2	1.33	2	1.5	2.5	1.5	2	1.75

COURSE NAME: QUALITY ASSURANCE AND REGULATORY ASPECTS OF MEDICAL EQUIPMENT
COURSE CODE: BME804C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Biomedical Instrumentation, Analytical and Diagnostic Equipment, Therapeutic Equipment and Implants, Imaging Instruments, Principles of management.

Course Outcomes:
After completion of this course students will be able to

CO1: Understand the basics of medical devices and process of development.

CO2: Investigate the various safety measures and regulatory requirements for approval of medical devices.

CO3: Conduct clinical evaluation, investigation and harmonize the initiatives for quality and ethical considerations for medical devices.

CO4: Develop knowledge and practical skills related to examine the broad scope of the medical device industry and its quality assurance practices.

Course Content:

Module- 1: Fundamentals of Quality Management 7L

Definition of Quality, Dimensions of Quality, Quality Planning – Quality costs. Analysis Techniques of quality Cost – Basic concepts of Total Quality Management, Historical Review. - Principles of TQM, Leadership – Concepts, Role of Senior Management – Quality Council, Quality Statements – Strategic Planning – Deming Philosophy – Barriers to TQM Implementation.

Module- 2: Introduction to Design Process and Safety 8L

Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modeling, machine elements, ergonomics and prototyping. Security and Safety of the Hospital-property, staff, patients, Electrical safety. Disposal of biological waste, personal protective equipment.

Module- 3: Design of Medical Devices and System 7L

Medical device classification, bioethics and privacy, biocompatibility and sterilization techniques, design of clinical trials, design control and regulatory requirements, introduction to specific medical technologies: biopotentials measurement (EMG, EOG, ECG, EEG), medical diagnostics (In-vitro diagnostics), medical diagnostics (Imaging), minimally invasive devices, surgical tools and implants.

Module- 4: Statistical Process Control 7L

Seven Tools of Quality: I, II, and III – Concept of Six Sigma: I and II – New Seven Management

tools: I and II – Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample – Normal Curve, Control Charts for Variables and attributes, Process capability.

Module- 5: TQM Tools **7L**

Benchmarking – Reasons to Benchmark – Benchmarking Process – Quality Function Deployment (QFD) – House of Quality– QFD Process – Benefits Taguchi Quality, Loss Function – Total Productive Maintenance (TPM) – Concept, Improvement Needs – FMEA -Stages of FMEA.

Text/ Reference Books:

1. Rose J.E, Total Quality Management, Kogan Page Ltd., 1993.
2. Cesar A. Cacere and Albert Zana, The Practice of clinical Engineering, Academic Press, New york, 1997.
3. John Bank, "The Essence of Total Quality Management", Prentice Hall of India, 1993.
4. Webster J G, and Albert Cook M, Clinical Engineering, Principles and Practices, Prentice Hall Inc., Engle wood cliffs, New Jersey, 1979.
5. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", Third Edition, ISBN9781466569133.

CO–PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	2	-	2	2	3	-	-	-	-
CO3	2	2	2	3	-	1	-	3	-	-	-	2
CO4	-	-	-	3	2	1	-	-	2	-	-	1
Avg.	2.33	2	2	2.67	2	1.33	2	3	2	-	-	1.5