Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

First Year First Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	A. THEORY			L	T	P	Total	
1	Basic Science course	PH101	Physics-I	3	0	0	3	3
2	Basic Science course	M101	Mathematics –I	4	0	0	4	4
3	Humanities and Social Sciences including Management	HSMC 101	Professional Communication	2	0	0	2	2
	B. PRACTICAL							
4	Basic Science course	PH191	Physics-I Lab	0	0	3	3	1.5
5	Engineering Science Courses	ME 191	Workshop & Manufacturing Practices Lab	0	0	3	3	1.5
6	PROJECT	PR191	Theme based Project I	0	0	1	1	0.5
7	PROJECT	PR192	Skill Development I: Soft Skill	0	0	1	1	0.5
	C. MANDATORY ACTIVITIES / COURSES							
8	Mandatory Course	MC181	Induction Program	0	0	0	0	2Units
	TOTAL CREDIT							**13.0**

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First Year Second Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	A. THEORY			L	T	P	Total	
1	Basic Science courses	CH 201	Chemistry-I	3	0	0	3	3
2	Basic Science courses	M 201	Mathematics –II	4	0	0	4	4
3	Engineering Science Courses	EE 201	Basic Electrical Engineering	3	0	0	3	3
4	Engineering Science Courses	CS 201	Programming for Problem Solving	3	0	0	3	3
	B. PRACTICAL							
5	Basic Science course	CH 291	Chemistry-I Lab	0	0	3	3	1.5
6	Humanities and Social Sciences including Management courses	HSMC 191	Professional Communication Lab	0	0	2	2	1.0
7	Engineering Science Courses	EE 291	Basic Electrical Engineering Lab	0	0	3	3	1.5
8	Engineering Science Courses	ME 292	Engineering Graphics & Design Lab	0	0	3	3	1.5
9	Engineering Science Courses	CS 291	Programming for Problem Solving Lab	0	0	3	3	1.5
10	PROJECT	PR291	Theme based Project II	0	0	1	1	0.5
11	PROJECT	PR292	Skill Development II: Life Skill	1	0	0	1	0.5
	C. MANDATORY ACTIVITIES / COURSES							
12	Mandatory Course	MC281	NSS/Physical Activities / Meditation & Yoga / Photography	0	0	3	3	3 Units
	TOTAL CREDIT							**21.0**

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Second Year Third Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Basic Science course	M 301	Mathematics III	3	0	0	3	3
2	Engineering Science Courses	EC(BME)301	Analog Electronics & Circuit Theory	3	0	0	3	3
3	Program Core Course	BME 301	Human Anatomy and Physiology	3	0	0	3	3
4	Program Core Course	BME 302	Biophysical Signals & Systems	3	0	0	3	3
5	Program Core Course	BME 303	Biomechanics I	3	0	0	3	3
6	Humanities and Social Sciences including Management courses	HSMC 303	Universal Human Values 2: Understanding Harmony	3	0	0	3	3
B. PRACTICAL								
7	Engineering Science Courses	CS 391	Numerical Methods lab	0	0	3	3	1.5
8	Engineering Science Courses	EC 391	Analog Electronics and Circuit Theory Lab	0	0	3	3	1.5
9	Program Core Course	BME 391	Human Anatomy and Physiology Lab	0	0	3	3	1.5
10	Program Core Course	BME 392	Biophysical Signals & Systems Lab	0	0	3	3	1.5
11	PROJECT	PR391	Theme based Project III	0	0	1	1	0.5
12	PROJECT	PR392	Skill Development III: Technical Seminar Presentation	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 301	Environmental Science	3	0	0	3	3 Units
TOTAL CREDIT WITHOUT MOOCS COURSES								**25.0**
D.MOOCS COURSES**								
14	MOOCS COURSES	HM301	MOOCS COURSE-I	1	3	1	4	4
TOTAL CREDIT WITH MOOCS COURSES								**29.0**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

R21 B.TECH BME

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Under Autonomy

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Second Year Fourth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Basic Science course	PH (BME) 401	Physics-II	3	0	0	3	3
2	Engineering Science Courses	EC (BME)402	Digital Electronics & Devices	3	0	0	3	3
3	PC	BME 401	Biomaterials	3	0	0	3	3
4	PC	BME 402	Biomechanics II	3	0	0	3	3
5	PC	BME 403	Bioelectrical & Bioelectronic Measurement	3	0	0	3	3
6	Humanities and Social Sciences including Management courses	HSMC 402	Gender Culture and Development	2	0	0	2	2
B. PRACTICAL								
7	Engineering Science course	PH (BME) 491	Physics-II lab	0	0	2	2	1
8	Engineering Science Courses	EC (BME)402	Digital Electronics & Devices Lab	0	0	3	3	1.5
9	PC	BME 491	Biomaterials Lab	0	0	3	3	1.5
10	PC	BME 492	Biomechanics Lab	0	0	3	3	1.5
11	PROJECT	PR 491	Theme based Project IV	0	0	1	1	0.5
12	PROJECT	PR492	Skill Development IV: Soft Skill & Aptitude-I	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 481	Environmental Protection Initiatives OR Learning an Art Form [vocal or instrumental, dance, painting, clay modeling, etc.]	0	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.5**
D.MOOCS COURSES								
14	MOOCS COURSES	HM401	MOOCS COURSE-II	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.5**

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Third Year Fifth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Humanities and Social Sciences including Management courses	HSMC 505	Principles of Management	2	0	0	2	2
2	PC	BME 501	Biomedical Instrumentation	3	0	0	3	3
3	PC	BME 502	Biosensors & Transducers	3	0	0	3	3
4	PC	BME 503	Medical Imaging Systems I	3	0	0	3	3
5	PE	BME 504A BME 504B BME 504C	Communication & Biotelemetry Modelling of Physiological Systems Biomedical Informatics	3	0	0	3	3
6	OE	BME 505A BME 505B BME 505C	Data Structure & Algorithm VLSI & Embedded System Measurements and Control Systems	3	0	0	3	3
B. PRACTICAL								
7	PC	BME 591	Biomedical Instrumentation Lab	0	0	3	3	1.5
8	PC	BME 592	Biosensors & Transducers Lab	0	0	3	3	1.5
9	OE	BME 595A BME 595B BME 595C	Data Structure & Algorithm Lab VLSI & Embedded System Lab Measurements and Control Systems Lab	0	0	3	3	1.5
10	PROJECT	PR 591	Minor Project I	0	0	3	3	1
11	PROJECT	PR 592	Skill Development V: Soft Skill & Aptitude-II	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC 501	Constitution of India	3	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D. MOOCS COURSES**								
13	MOOCS COURSES	HM501	MOOCS COURSE-III	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.0**

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Third Year Sixth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Humanities and Social Sciences including Management courses	HSMC 604	Economics for Engineers	2	0	0	2	2
2	PC	BME 601	Analytical & Diagnostic Equipment	3	0	0	3	3
3	PC	BME 602	Biosignal Processing	3	0	0	3	3
4	PC	BME 603	Medical Imaging Systems II	3	0	0	3	3
5	PE	BME 604A BME 604B BME 604C	Biophysics & Biochemistry Nanobiotechnology Tissue Engineering	3	0	0	3	3
6	OE	BME 605A BME 605B BME 605C	Database Management System Microprocessor & Microcontroller Soft Computing	3	0	0	3	3
B. PRACTICAL								
7	PC	BME 691	Analytical & Diagnostic Equipment Lab	0	0	3	3	1.5
9	PC	BME 692	Biosignal Processing Lab	0	0	3	3	1.5
10	OE	BME 695	Database Management System Lab Microprocessor & Microcontroller Lab Soft Computing Lab	0	0	3	3	1.5
11	PROJECT	PR 691	Minor Project II	0	0	3	2	1
12	PROJECT	PR 692	Skill Development VI: Soft Skill & Aptitude-III	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 601	Intellectual Property Right	3	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D.MOOCS COURSES**								
14	MOOCS COURSES	HM601	MOOCS COURSE-IV	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.0**

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Fourth Year Seventh Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours /Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PC	BME 701	Therapeutic Equipment	3	0	0	3	3
2	PE	BME 702A BME 702B BME 702C	Medical Image Processing Medical Robotics & Automation Neural Network & Genetic Algorithm	3	0	0	3	3
3	PE	BME 703A BME 703B BME 703C	Hospital Engineering & Management BioMEMs & BioMicrofluidics Drug Delivery System	3	0	0	3	3
4	OE	BME 704A BME 704B BME 704C	IOT and Telehealth Technology Deep Learning & Machine Learning in Health Care Artificial Intelligence in Clinical Science	3	0	0	3	3
B. PRACTICAL								
5	PC	BME 791	Therapeutic Equipment Lab	0	0	0	3	1.5
6	PE	BME 792A BME 792B BME 792C	Medical Image Processing Lab Medical Robotic & Automation Lab Neural Network & Genetic Algorithm Lab	0	0	3	3	1.5
7	PROJECT	PR 791	Major Project-I	0	0	0	4	2
8	PROJECT	PR 792*	Industrial Training / Internship	0	0	0	0	1
9	PROJECT	PR 793	Skill Development VII: Seminar & Group Discussion	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
10	MC	MC 781	Entrepreneurship & Innovation Skill	0	0	3	3	3 Units
TOTAL CREDIT WITHOUT MOOCS COURSES								**18.5**
D.MOOCS COURSES**								
11	MOOCS COURSES	HM701	MOOCS COURSE-V	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**22.5**

***Collective Data from 3rd to 6th Semester (Summer/Winter Training during Semester Break & Internship should be done after 5th Semester or 6th Semester). All related certificates to be collected by the training/internship coordinator(s).**

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4th Year 2nd Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours /Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PC	BME 801	Artificial Organ & Rehab Engineering	3	0	0	3	3
2	PE	BME 802A BME 802B BME 802C	Biological Control System Computational Biology Quality Assurance & Regulatory aspects of Medical Equipment	3	0	0	3	3
3	PE	BME 803A BME 803B BME 803 C	Laser and Fiber Optics in Healthcare Radiotherapy and Nuclear Medicine Troubleshooting and Maintenance of Medical Equipment	3	0	0	3	3
B. PRACTICAL								
4	PROJECT	PR 891	Major Project-II	0	0	0	12	6
5	PROJECT	PR 892	Grand Viva	0	0	0	0	1
C. MANDATORY ACTIVITIES / COURSES								
8	MC	MC 881	Essence of Indian Knowledge Tradition	0	0	3	3	3 Units
TOTAL CREDIT								**16**

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Total:

Total for BME	
Without MOOCS	**With MOOCS**
34.0	**34**
25.0	**29.0**
23.5	**27.5**
23.0	**27.0**
23.0	**27.0**
18.5	**22.5**
16.0	**16.0**
163	**183 (for Honors/minor)**

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Credit Distribution

Subject Category	Subjects	Credit Distribution as per AICTE (%)	Suggested Breakup of Credits (Total 160) as per AICTE	
Humanities and Social Sciences including Management courses **(HSMC)**	**Humanities & Social Science:** (i)English (ii)Language / English Lab **Management courses** (i)Principle of Management, (ii)Economics for Engineers (iii)Principles of Management (iv)Values & Ethics in Profession	**5 to 10%**	**12**	**12** **9+3** **5.63%**
Basic Sciences (BS)	**Physics** (i)Introduction to Electromagnetic Theory (ii)Introduction toMechanics (iii)Quantum Mechanics forEngineers (iv)Oscillation, Waves andOptics (v)Semiconductor Optoelectronics	**15 to 20%**	**25.5**	**24[IT, BME, ME, CE]** **15.00 %**

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	(vi)Semiconductor Physics			
	Chemistry & Biology (i)Chemistry – I (Concepts in chemistry for engineering) (ii)Chemistry Laboratory **Elective Courses** (i)Chemistry-II (Chemical Applications) (ii)Polymer Chemistry (iii)Experiments in Polymer Chemistry **Biology**			
	Mathematics **(i)Mathematics (Option 1)** Mathematics 1 Mathematics 2 Mathematics 3 **(ii)Mathematics (Option 2)** (for CSE students)			
Engineering Sciences and Skills (ES)	(i)Workshop / Manufacturing Practice (ii)Drawing / Engineering Graphics & Design, (iii)Basics of Electrical (iv)Computer / Programming for Problem Solving (v)Numerical Methods (vi)Circuit theory	**15 to 20%**	**24**	**22.5** **14.06%**
Professional core courses	Courses relevant to chosen branch	**30 to 40%**	**48**	**55.5**

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(PC)				**34.69%**
Professional Elective	Elective courses relevant to chosen specialization/branch	**10 to 15%**	**18**	**19.5** **12.19%**
Open Elective	Elective Courses from other technical programs and /or **emerging subjects**: 1.Artificial Intelligence (AI) 2. Internet of Things (IoT) 3. Block Chain 4. Robotics 5. Quantum Computing 6. Data Sciences 7. Cyber Security 8. 3D Printing and Design 9. Virtual Reality (VR)	**5 to 10%**	**8**	**12** **7.5%**
Project work, seminar and internship in industry or elsewhere	(i)PROJECT (PR….91): Project work (ii)PROJECT (PR….92): (iii) PROJECT (PR …93):	**10 to 15%**	**15**	**17.5** **10.94 %**

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	(iv)Grand Viva - 1			
Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	**MC Courses:** (i)Environmental Science, (ii)Foreign language, (iii)Constitution of India (iv)Behavioral & Interpersonal skills (v)Essence of Indian Knowledge Tradition **& others as mentioned in AICTE guidelines** **MC Activities:** (i)Induction Programming (ii)NSS/NCC/Yoga (iii)Technical Lecture Presentation **& others as mentioned in AICTE guidelines**	**No Credit Course**	Minimum 2 units per semester min. Max: 28 Units/Program	

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Summary

Sub	Credit	%	AICTE %
HSMC	9	5.63	5to10
BSHU	24	15.00	15to20
ES	22.5	14.06	15to20
PC	55.5	34.69	30to40
PE	19.5	12.19	10to15
OE	12	7.50	5to10
Project	17.5	10.94	10to15
	160	100.00	

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Professional Electives (It is expected Options in a vertical column would lead to expertise in a specific/allied domain)				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Professional Elective I	Communication & Biotelemetry	Physiological Modelling	Biomedical Informatics	
Professional Elective II	Biophysics & Biochemistry	Nanobiotechnology	Tissue Engineering	
Professional Elective III	Medical Image Processing	Medical Robotics & Automation	Neural Network & Genetic Algorithm	
Professional Elective IV	Hospital Engineering & Management	BioMEMs & BioMicrofluidics	Drug Delivery System	
Professional Elective V	Biological Control System	Computational Biology	Quality Assurance & Regulatory aspects of Medical Equipment	
Professional Elective VI	Laser and Fiber Optics in Healthcare	Radiotherapy and Nuclear Medicine	Troubleshooting and Maintenance of Medical Equipment	

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Open Electives (It is expected Options in a vertical column would lead to expertise in a specific/allied domain)				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Open Elective I	Data Structure & Algorithm	VLSI & Embedded System	Measurements and Control Systems	
Open Elective II	Database Management System	Microprocessor & Microcontroller	Soft Computing	
Open Elective III	IOT and Telehealth Technology	Deep Learning & Machine Learning in Health Care	Artificial Intelligence in Clinical Science	
Open Elective IV				

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MOOCs (It is expected Options in a vertical column would lead to expertise in a specific/allied domain)						
	Sem	Credit	Option 1	Option 2	Option 3	Option 4
MOOCS COURSE-I	III	4	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors
MOOCS COURSE-II	IV	4	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors
MOOCS COURSE-III	V	4	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors
MOOCS COURSE-IV	VI	4	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors
MOOCS COURSE-V	VII	4	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors	Related to Minor/Honors

**Please define your Honors/Minor programme credit point of 20 to be earned by the student. Related BoS would endorse the selection of these courses followed by the necessary intimation at the Academic Council of the Institute.

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1st Year 1st Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	D. THEORY			L	T	P	Total	
1	Basic Science course	PH101	Physics-I	3	0	0	3	3
2	Basic Science course	M101	Mathematics –I	4	0	0	4	4
3	Humanities and Social Sciences including Management	HSMC 101	Professional Communication	2	0	0	2	2
	E. PRACTICAL							
4	Basic Science course	PH191	Physics-I Lab	0	0	3	3	1.5
5	Engineering Science Courses	ME 191	Workshop & Manufacturing	0	0	3	3	1.5
6	PROJECT	PR191	Theme based Project I	0	0	1	1	0.5
7	PROJECT	PR192	Skill Development I: Soft Skill	0	0	1	1	0.5
	F. MANDATORY ACTIVITIES / COURSES							
8	Mandatory Course	MC181	Induction Program	0	0	0	0	2Unit
	TOTAL CREDIT							**13.0**

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COURSE NAME: PHYSICS –I
COURSE CODE: PH 101
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

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

Course Outcome:

At the end of the course students should be able to

CO1: Describe various types of oscillating systems, mechanical resonance and its electrical equivalence.

CO2: Explain basic principles of Laser, Optical fibers and Polarization of light.

CO3: Apply superposition principle to explain interference and diffraction, formation of Lissajous figures.

CO4: Analyze different crystallographic structures according to their co-ordination number and packing factors, effect of various level of damping to an oscillating system.

CO5: Justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics and user to probability waves to represent microscopic systems.

Course Content

Module-1: Waves & Oscillations **5L**

Simple Harmonic Motion (Recap), superposition of waves, damped harmonic motion-over damped, critically damped and under damped motion, energy decay, logarithmic decrement, force vibration and resonance (amplitude, velocity resonance), sharpness of resonance, quality factor, related numerical problems. **5L**

Module-2: Classical Optics **12L**

2.1: Interference of light-Huygens's principle, conditions of sustained interference, classification of interference, Newton's ring (qualitative descriptions of working principles and procedures-no deduction required). Engineering applications, related numerical problems. **4L**

2.2: Diffraction of light- Fresnel and Fraunhofer class, Fraunhoffer diffraction of a single slit, double slit, multiple slits, intensity distributions, missing order, Rayleigh criterion (no deduction) and resolving power of grating and microscope (no deduction), related numerical problems. **4L**

2.3: Polarization-Definition, Plane of polarization, Plane of vibration, Malus Law, Fundamental concepts of plane, circular & elliptical polarizations (only qualitative idea) with examples, Brewster's law, Double refraction: Ordinary & Extra ordinary rays, positive and negative crystal, Nicol's prism, Numerical problems. **4L**

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

3.1: 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. **4L**

3.2: Quantum Mechanics1-Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions; uncertainty principle, relevant numerical problems. Introduction of Schrödinger wave equation (only statement). **4L**

Module-4: Solid State Physics-I **3L**

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**

Module- 5: Modern Optics-I **8L**

5.1: 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. **5L**

5.2: 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**

Recommended Text Books for Physics I:

Waves & Oscillations:

1. Sound-N. K. Bajaj (TMH)
2. Advanced Acoustics-D. P. Roy Chowdhury (Chayan Publisher)
3. Principles of Acoustics-B.Ghosh (Sridhar Publisher)
4. A text book of sound-M. Ghosh (S. Chand publishers)
5. A text book of Light- K.G. Mazumder & B. Ghosh, (Book & Allied Publisher)
6. Physics of Oscillations and Waves- R.P. Singh
7. College Physics Vol. II - A.B. Gupta
8. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:

1. A text book of Light- K.G. Mazumder & B. Ghosh (Book & Allied Publisher)
2. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers)
3. Modern Optics-A. B. Gupta (Book& Allied Publisher)
4. Optics-Ajay Ghatak (TMH)
5. Optics-Hecht
6. Optics-R. Kar, Books Applied Publishers
7. Physical Optics Möler
8. Optics -F.A. Jenkins and H.E White

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Quantum Mechanics-I

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde and Singh (S. Chand Publishers)
3. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
4. Quantum Mechanics-Binayak Datta Roy (S. Chand Publishers)
5. Quantum Mechanics-Bransden (Pearson Education Ltd.)
6. Perspective of Modern Physics-A. Beiser (TMH)
7. Quantum mechanics -A.K. Ghatak and S Lokenathan
8. Modern Physics -E.E. Anderson
9. Physics Volume 2 -Haliday, Resnick & Krane, Published by Wiley India

Solid State Physics-I:

1. Solid state physics-Puri&Babbar(S. Chand publishers)
2. Materials Science & Engineering-KakaniKakani
3. Solid state physics- S. O. Pillai
4. Introduction to solid state physics-Kittel (TMH)
5. Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)
6. Problem in Solid state physics -S.O. Pillai (a. b.)

Text Books:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics-Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Perspective & Concept of Modern Physics -Arthur Baiser
4. Principles of engineering physics – Md. N Khan and S Panigrahi.
5. Basic Engineering Physics-Sujoy Bhattacharya, Saumen Pal (MG)
6. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila(S. Chand Publishers)
7. Engineering Physics-A. S. Vasudeva

CO-PO Mapping:

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

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COURSE NAME: MATHEMATICS-I
COURSE CODE: M 101
CONTACT: 3:1:0
TOTAL CONTACT HOURS: 48
CREDITS: 4

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

Course Outcomes (COs):

On successful completion of the learning sessions of the course, the learner will be able to

CO1: Recall the properties and formula related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.

CO2: Determine the solutions of the problems related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.

CO3: Apply the appropriate mathematical tools of matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series for the solutions of the problems.

CO4: Analyze different engineering problems linked with matrix algebra, differential calculus, multivariable calculus, vector calculus.

Course Content:

Module I: Matrix Algebra **11L**

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; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton theorem.

Module II: Differential Calculus and Infinite Series **10L**

Rolle’s Theorem, Mean value theorems, Taylor’s and Maclaurin theorems with remainders; Concept of sequence and series, Tests for convergence of infinite series: Comparison test, D’Alembert’s ratio test, Raabe’s test, Cauchy’s root test, Leibnitz’s Test, Power series; Taylor's series, Series for exponential, trigonometric and logarithm functions.

Module III: Multivariable Calculus (Differentiation) **13L**

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, Method of Lagrange multipliers.

Module IV: Multivariable Calculus (Integration) 6L

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

Module V: Vector Calculus 8L

Gradient, Directional derivatives, Divergence, Curl, vector line integrals, vector surface integrals, vector volume integrals, Green's theorem, Gauss divergence theorem and Stokes' theorem.

Project Domain:

1. Study on eigenvalues and eigenvectors.
2. Study on convergence of infinite series.
3. Application of partial derivatives.
4. Application of vector calculus
5. Application of integral calculus.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
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. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics-I, New age International Publishers

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

2. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
3. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
4. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
6. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

CO-PO Mapping:

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: PROFESSIONAL COMMUNICATION
COURSE CODE: HSMC 101
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Prerequisites: Basic (10+2) level of knowledge of English grammar, vocabulary reading and writing skills.

Course Outcomes:

After attending the course students should be able to

CO1: Apply the modalities and nuances of communication in a workplace context.

CO2: Analyze communication across cultures and societies.

CO3: Apply the basic formats, templates of business and official communication.

CO4: Employ formal communication modes in meetings and reports.

CO5: Justify importance of culturally neutral language in interpersonal and business communication.

Course Content:

Module- 1: Verbal and Non-verbal communication **4L**

1.1: Definition, Relevance and Effective Usage
1.2: Components of Verbal Communication: Written and Oral Communication
1.3: Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics Paralanguage
1.4: Barriers to Effective Communication

Module- 2: Social Communication Essentials and Cross-Cultural Communication **6L**

2.1: Communication in Society and the Workplace
2.2: Greetings, Courtesies and Socially Useful Language
2.3: Cultural Contexts: High Context and Low Context Cultures
2.4: Understanding Cultural Nuances and Stereotyping
2.5: Achieving Culturally Neutral Communication in Speech and Writing

Module- 3: Meetings **4L**

3.1: Meetings: Nature and Types
3.2: Conducting Meetings: Organization and Procedures
3.3: Meeting Coordination: Roles of Chairpersons and Members

3.4: Notice and Agenda for a Meeting
3.5: Preparing the Minutes of a Meeting (MOM)

Module- 4: Report Writing **4L**

4.1: Nature and Function of Reports
4.2: Types of Reports
4.3: Researching for a Business Report
4.4: Format, Language and Style
4.5: Report Documentation

Module 5: Employment Communication **6L**

5.1: Writing Business Letters- (Enquiry, Order, Sales, Complaint, Adjustment, Job Application, Offer)
5.2: Preparing a CV or Rẽsumẽ
5.3: Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)
5.4: Writing E-mails: types, convention, and etiquette
5.5: Memo, Notices and Circulars
5.6: Writing Technicalities—Paragraphing, Sentence Structure and Punctuation

Text Books &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. Lesikar et al. *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 JobApplications*. 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: 21st Century 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/

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CO-PO Mapping

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

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COURSE NAME: PHYSICS- I LAB
COURSE CODE: PH 191
CONTACT: 0:0:3
CREDITS: 1.5

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

Course Outcome

At the end of the course students will be able to

CO1: Demonstrate experiments allied to their theoretical concepts.

CO2: Conduct experiments using LASER, Optical fiber, Torsional pendulum, Spectrometer.

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 experiments.

General idea about Measurements and Errors (One Mandatory):

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

ii) Proportional error calculation using Carrey Foster Bridge.

Any 6 to be performed from the following experiments

Experiments on Waves & Oscillations:

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of elastic moduli of different materials (Young's modulus /Rigidity modulus)
3. Determination of Q factor using LCR Circuit.
4. Calibration of an oscillator using Lissajous Figure.

Experiments on Classical Optics:

5. Determination of wavelength of light by Newton's ring method.
6. Determination of wavelength of light by Laser diffraction method.
7. To determine the angle of optical rotation of a polar solution using polarimeter

Experiments on Quantum Physics-I:

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

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

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Probable experiments beyond the syllabus:

1. Determination of wavelength of light by Fresnel's bi-prism method (beyond the syllabus).
3. Study of dispersive power of material of a prism.
4. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.
5. Measurement of nodal and antipodal points along transmission wire and measurement of wavelength.
6. Any other experiment related to the theory**.**

Recommended Text Books for Physics I Lab

Waves & Oscillations:

1. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:

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

Quantum Mechanics-I

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

Solid State Physics-I:

1. 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	3	2	-	-	-	-	-	-	-	-	-	2
CO2	2	2	-	3	-	-	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	3	-	-	2
CO4	2	2	-	-	-	-	-	-	-	2	-	2

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: WORKSHOP/MANUFACTURING PRACTICES
COURSE CODE: ME191
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Higher Secondary with Mathematics, Physics and Chemistry.

Course Outcomes:

After completion of this course students will be able to

CO1: Identify and operate various hand tools related to variety of manufacturing operations

CO2: Safely fabricate simple components with their own hands.

CO3: Get practical knowledge of the dimensional accuracies and tolerances applicable for different manufacturing processes.

CO4: Produce small devices of their interest for project or research purpose.

Course Content:

(i) Theoretical discussion & videos: 3P

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
8. Plastic moulding & Glass Cutting

(ii) Workshop Practice:

Module 1 - Machine shop 6P

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 6P

Typical jobs that may be made in this practice module:

i. To make a Gauge from MS plate.

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Module 3 - Carpentry **6P**

Typical jobs that may be made in this practice module:

i. To make wooden joints and/or a pattern or like.

Module 4 - Welding shop (Arc welding 3P + gas welding 3P) **3P**

Typical jobs that may be made in this practice module:

i. ARC WELDING (3P): To join two thick (approx. 5mm) MS plates by manual metalarcwelding.

ii. GAS WELDING (3P): To join two thin mild steel plates or sheets by gas welding.

Module 5 - Electrical & Electronics **3P**

House wiring, soft Soldering

Module 6 – Smithy **3P**

Typical jobs that may be made in this practice module:

i. A simple job of making a square rod from a round bar or similar.

For further study (Optional)

Module 7 - Casting **3P**

Typical jobs that may be made in this practice module:

i. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 8 - Plastic Moulding & Glass Cutting **3P**

Typical jobs that may be made in this practice module:

i. For plastic moulding, making at least one simple plastic component should be made.

ii. At least one sample shape on glass should be made using laser cutting machine.

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 McGrawHill House, 2017.

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Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – 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:

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

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1st Year 2nd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
	D. THEORY			L	T	P	Total	
1	Basic Science courses	CH 201	Chemistry	3	0	0	3	3
2	Basic Science courses	M 201	Mathematics –II	4	0	0	4	4
3	Engineering Science Courses	EE 201	Basic Electrical Engineering	3	0	0	3	3
4	Engineering Science Courses	CS 201	Programming for Problem Solving	3	0	0	3	3
	E. PRACTICAL							
5	Basic Science course	CH 291	Chemistry-I Lab	0	0	3	3	1.5
6	Humanities and Social Sciences including Management courses	HSMC 291	Professional Communication Lab	0	0	2	2	1.0
7	Engineering Science Courses	EE 291	Basic Electrical Engineering Lab	0	0	3	3	1.5
8	Engineering Science Courses	ME 292	Engineering Graphics & Design Lab	0	0	3	3	1.5
9	Engineering Science Courses	CS 291	Programming for Problem Solving Lab	0	0	3	3	1.5
10	PROJECT	PR291	Theme based Project II	0	0	1	1	0.5
11	PROJECT	PR292	Skill Development II: Life Skill	1	0	0	1	0.5
	F. MANDATORY ACTIVITIES / COURSES							
12	Mandatory Course	MC281	NSS/Physical Activities / Meditation & Yoga / Photography	0	0	3	3	3 Units
	TOTAL CREDIT							**21.0**

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COURSE NAME: CHEMISTRY
COURSE CODE: CH 201
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: A basic knowledge in 10+2 science with chemistry

Course Outcomes

After completion of this course students will be able to

CO1: Describe the fundamental properties of atoms & molecules, atomic structure and the periodicity of elements in the periodic table

CO2: Apply fundamental concepts of thermodynamics in different engineering applications.

CO3: Apply the knowledge of water quality parameters, corrosion control & polymers to different industries.

CO4: Determine the structure of organic molecules using different spectroscopic techniques.

CO5: Evaluate theoretical and practical aspects relating to the transfer of the production of chemical products from laboratories to the industrial scale, in accordance with environmental considerations.

Course Content

Module- I: Inorganic Chemistry **9L**

(i) Atomic structure **5L**

Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers, Introduction to the concept of atomic orbitals, diagrams of s, p and d orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation, introduction to Schrodinger equation.

(ii) Periodic properties **4L**

Modern Periodic table, group trends and periodic trends in physical properties: electron affinity, electronegativity, polarizability, oxidation states, effective nuclear charges, penetration of orbitals, variations of s, p and d orbital energies of atoms.

Module II: Physical Chemistry **8L**

(i) Use of free energy in chemical equilibria **6L**

Thermodynamic functions: internal energy, enthalpy, entropy and free energy. 2^{nd} Law of Thermodynamics, Estimations of entropy and free energies, Free energy and emf, Cell potentials, the Nernst equation and applications.

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(ii) Real Gases **2L**

Reason for deviation of real gases from ideal behavior, Equations of state of real gases,Vander Waals' equation, pressure & volume correction, validity, critical state of gas.

Module III: Organic Chemistry **8L**

(i) Stereochemistry **4L**

Representations of 3 dimensional structures, Chirality, optical activity, isomerism, structural isomerism, stereoisomers, enantiomers, diastereomers, configurations (D,L& cis trans), racemisation.

(ii) Organic reactions **4L**

Concepts of inductive effect, resonance, hyperconjugation, introduction to reactions involving substitution, addition, elimination, oxidation (Baeyer villiger oxidation), reduction (Clemmensen reduction, Wolff-Kishner reduction).

Module IV: Industrial Chemistry **8L**

(i) Water **2L**

Hardness, alkalinity, numerical

(ii) Corrosion. **2L**

Types of corrosion: wet & dry, preventive measures

(iii) Polymers **3L**

Classification of polymers, conducting polymers, biodegradable polymers

(iv) Synthesis of a commonly used drug molecule. **1L**

Paracetamol, Aspirin

Module V: Spectroscopic techniques in Chemistry **3L**

Electromagnetic radiation, Principles of spectroscopy, spectrophotometer, infrared spectroscopy, fingerprint region, functional group region, UV-VIS spectroscopy, ^{1}H Nuclear magnetic resonance spectroscopy, chemical shift.

Project Domain

1. Application of Thermodynamics
2. Application of polymers in daily life
3. Nanomaterials and its applications
4. Determination of water quality parameters
5. Electronic storage devices
6. Managing E –wastes
7. Application of chemistry in core engineering
8. Application of spectroscopy in medical field
9. Applications of green chemistry
10. Merits of commercial organic products

11. Bioplastics
12. Any other related topics

Text Books

1. A Text Book of Organic Chemistry, Arun Bahl & Arun Bahl
2. General & Inorganic Chemistry, P.K. Dutt
3. General & Inorganic Chemistry, Vol I, R.P. Sarkar
4. Physical Chemistry, P.C. Rakshit

Reference Books

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
2. Fundamentals of Molecular Spectroscopy, by C. N.Banwell
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
4. Physical Chemistry, by P. W. Atkins
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Editionhttp://bcs.whfreeman.com/vollhardtschore5e/default.asp

CO-PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MATHEMATICS-II
COURSE CODE: M 201
CONTACT: 3:1:0
TOTAL CONTACT HOURS: 48
CREDIT: 4

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

Course Outcomes:

On successful completion of the learning sessions of the course, the learner will be able to

CO1: Recall the properties and formula related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.

CO2: Determine the solutions of the problems related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.

CO3: Apply appropriate mathematical tools of ordinary differential equations, improper integral, Laplace transform and numerical techniques for the solutions of the problems.

CO4: Analyze engineering problems by using differential equation, Laplace Transform and Numerical Methods.

Course Content:

Module I: First Order Ordinary Differential Equations (ODE): 10L

Solution of first order and firstdegree 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 solvable for x and Clairaut's equation.

Module II: Second Order Ordinary Differential Equations (ODE): 10L

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

Module III: Laplace Transform (LT): 14L

Improper integrals; Beta and Gamma functions and their properties.
Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $t\,f\,(t)$, 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.

Module IV: Numerical Methods **14L**

Introduction to error analysis, Calculus of finite difference. **Interpolation:** Newton forward and backward interpolation, Lagrange's interpolation, Newton's divided difference interpolation formula. **Numerical integration:** Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule. **Numerical solution of ordinary differential equation:** Euler method, Modified Euler method, Fourth order Runge-Kutta method.

Project Domains:

1. Mathematical modeling using ODE.
2. Application of ODE.
3. Application of Laplace Transform in different engineering branches.
4. Application of Numerical Methods in different engineering branches.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
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. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics-II, New age International Publishers
7. Mollah, S. A, Numerical Analysis and Computational Procedures, Books and Allied (P) Ltd.

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Boyce, W. E. and DiPrima, R. C., Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
3. Ross, S. L., Differential Equations, 3rd Ed., Wiley India, 1984.
4. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

5. Coddington, E. A., An Introduction to Ordinary Differential Equations, Prentice Hall, India, 1995.
6. Dey, Sukhendu, Gupta Sisir, Numerical Methods, MsGraw Hill Education(India) Private Limited.
7. Jain, M. K., Iyengar, S. R. K., Jain, R. K., Numerical Methods, New age International Publishers

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	2	3	2	2	-	-	-	-	-	-	-	2

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BASIC ELECTRICAL ENGINEERING
COURSE CODE: EE201
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

Course Outcome:

After attending the course students would be able to

CO1: Understand and analyze basic electric circuits

CO2: Study the working principles of electrical machines.

CO3: Introduce the components of low voltage electrical installations

CO4: Study the fundamentals of electrical Power systems and Control Systems

Course Content

Module- I: DC Circuits **8L**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, active and passive elements, Kirchhoff‘s laws, Source equivalence and conversion, Network Theorems - Superposition Theorem, Thevenin‘s Theorem, Norton Theorem, Maximum Power Transfer Theorem, Star-Delta Conversions.

Module- II: AC Fundamentals **8L**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Module- III: Electrical Machines **10L**

Transformer: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Rotating Machines - DC Machines: Brief idea on constructional features, classifications, working principle of both motor and generator. Simple problems on Voltage equation. Three-Phase Induction Motor: Basic concept of three phase circuit and production of rotating magnetic

field. Working principle of three-phase induction motor and torque-speed characteristics (concept only).

Module- IV: Electrical Installations **3L**

Earthing of Electrical Equipment, ideas of basic components- MCB, MCCB, ELCB, SFU, Megger. Types of Wires and Cables, Earthing.

Module- V: Fundamentals of Power Systems **5L**

Generation of power: Block schematic representation of Thermal and nuclear power plants. Renewable energy sources: solar, wind, tidal and geothermal (Block diagram and working only-No Problems). Power transmission: Typical electrical power transmission scheme-need for high voltage transmission-(Derivation is not needed, No Problems). Power Distribution: substation equipments, primary and secondary transmission and distribution systems- feeder, service mains.

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

Concept control systems, Objectives of control system, Types of control systems, Real examples of control systems.

Text books:

G. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.
1. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
2. Ashfaq Hussain, Basic Electrical Engineering, S. Chand Publication.
3. Chakrabarti, Nath & Chanda, Basic Electrical Engineering, TMH.
4. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education.

Reference books:

1. E. Hughes, ―Electrical and Electronics Technology‖, Pearson, 2010.
2. V. D. Toro, ―Electrical Engineering Fundamentals‖, Prentice Hall India, 1989.

CO-PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

Prerequisites: Number system, Boolean Algebra

Course Outcomes:

After completion of the course students would be able to

CO1: Understand the fundamental concept of Computer and mathematical knowledge and apply them in designing solution to engineering problem.

CO2: Understand the basic concept of C programming and use of data types/operators/input/output function for developing and implementing complete program leading to solution of mathematical and engineering problem.

CO3: Use conditional branching, iteration, recursion and formulate algorithms and programs in solvingmathematical/scientific/engineering problem leading to lifelong learning.

CO4: Understandthe concept ofarrays, pointers, file and dynamic memory allocation and apply it for problem solving and also create new data types using structure, union and enum.

CO5: Understand how to decompose a problem into functions and assemble into a complete program by means of modular programming possibly as a team.

Course Content:

Module-1: FundamentalsofComputer **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 numbersystems; Representation and interchanging of number in different number systems. Introduction to complements system, Representationofsignedandunsignednumbers in singed magnitude singed 1's complement system and signed 2's complement system.
Arithmetic–Addition and Subtraction (using1'scomplementand2'scomplement).
Representation of Characters-ASCII Code
Basics of Compiler, Interpreter and Assembler
Problemsolving – Basic concept of Algorithm. Representation of algorithm using flowchart and pseudo code. Some basic examples.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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 key words, data type & sizes, variable names, declaration, statements.
Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrement operators, bit wise 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: BranchandLoop **5L**

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else ladder.
Switch Case: break andcontinue; switch-case, concept of goto and labels
Loops - while, for, do while

Module-4: ProgramStructures **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 life time of variables
Cpre-processor: Pre-processing directive andmacro, 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, bitfields. Basics of union and enum, difference between structure and union.

Module-7: File in C **3L**

Fileshandling- opening and closing a file in different mode, formatted and unformatted files, Command line arguments, f open, f close, f get c, f put c, f print f, f scan f function.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. KanetkarY.-LetusC,BPBPublication,15th Edition

ReferenceBooks:

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

CO–PO Mapping:

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

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: CHEMISTRY LAB
COURSE CODE: CH 291
CONTACT: 0:0:3
CREDITS: 1.5

Pre-requisite: A basic knowledge in 10+2 science with chemistry.

Course Outcome:

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: Analyze and determine the composition of liquid and solid samples working as an individual and also as a team member.
CO3: Analyze different parameters of water considering environmental issues.
CO4: Synthesize drug and polymer materials.
CO5: Design innovative experiments applying the fundamentals of chemistry.

Course Content:

Choice of 10-12 experiments from the following:

1. Determination of surface tension andviscosity
2. Thin layerchromatography
3. Determination ofhardness ofwater
4. Determination of chloride content ofwater
5. Determination of the rate constant of areaction
6. Determination of cell constant and conductometric titration
7. pH metric titrations
8. Synthesis of apolymer/drug
9. Saponification/acid value of anoil
10. Chemical analysis of asalt
11. Chemical oscillations- Iodine clockreaction
12. Determination of the partition coefficient of a substance between two immiscible liquids
13. Adsorption of acetic acid bycharcoal
14. Estimation of iron in Mohr's salt solution by permanganometry (Redox Titration)
15. Innovative experiments (any one)
    - Synthesis of silver nano-particles

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

- Green synthesis

CO-PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: PROFESSIONAL COMMUNICATION LAB
COURSE CODE: HSMC 291
TOTAL CONTACT HOURS: 26
CREDIT: 1

Pre requisites: Basic knowledge of LSRW skills.

Course Outcome:

After attending the course students would be able to

CO1: Explain advanced skills of Technical Communication in English through Language Laboratory.

CO2: Apply listening, speaking, reading and writing skills in societal and professional life.

CO3: Demonstrate the skills necessary to be a competent Interpersonal communicator.

CO4: Analyze communication behaviours.

CO5: Adapt to multifarious socio-economical and professional arenas with the help of effective communication and interpersonal skills.

Course Content:

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. Academic Listening vs Business Listening
d. Listening in Business Telephony
e. Study of Contextualized Examples based on Lab Recordings

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. Business Meetings and Sales Talks

Module- 4: Lab Project Work

a. Making a brief Advertisement video (1-2 minutes)
b. Making a brief Business Documentary film (5-7 minutes)
c. Client interaction video (5-7 minutes)
d. Making a short video CV (1-2 minutes)

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	-	-	-	-	-	2	-	-	3	-	2
CO2	2	3	2	-	-	2	2	2	-	3	-	3
CO3	2	3	-	-	-	3	3	3	-	3	-	3
CO4	-	-	-	-	-	3	3	3	-	3	-	3
CO5	-	-	-	-	-	-	3	3	-	3	-	3

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BASIC ELECTRICAL ENGINEERING LAB
COURSE CODE: EE291
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

Course Outcome:

After completion of this course students will be able to

CO1: Identify and use common electrical components.

CO2: To develop electrical networks by physical connection of various components and analyze the circuit behaviour.

CO3: Apply and analyze the basic characteristics of transformers and electrical machines.

List of Experiments

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Verification of Thevenin's and Norton's Theorem.
3. Verification of Superposition and Maximum Power Transfer Theorem.
4. Characteristics of Fluorescent, Tungsten and Carbon filament lamps.
5. Study of R-L-C series circuit.
6. Three-phase Power measurement with two wattmeter methods.
7. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
8. Measurement of primary and secondary voltage and current of single-phase transformer – Open Circuit and Short Circuit Test.
9. Starting, Reversing and speed control of DC shunt motor.
10. Torque-Speed characteristics of DC Machine.
11. Torque-Speed characteristics of Three-phase Induction Motor.
12. Test on single-phase Energy Meter.
13. Innovative experiments

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ENGINEERING GRAPHICS & DESIGN
COURSE CODE: ME292
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Basic knowledge of geometry

Course Outcomes:

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

CO2: Know 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 differentEngineering viewpoints.

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

List of Drawing:

Traditional 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 Involute; 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 tolerancing; 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 wireframe 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. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher

CO-PO Mapping:

COs	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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

Prerequisites: Number system, Boolean Algebra

Course Outcomes:

After completion of the course students will be able to

CO1: Understand and propose appropriate command or function in running system or developing program for engineering and mathematical problems depending on the platform used even in changed environment leading to their lifelong learning.

CO2: Identify and propose appropriate data type, arithmetic operators, input/output functions and also conditional statements in designing effective programs to solve complex engineering problem using modern tools.

CO3: Design and develop effective programs for engineering and mathematical problems using iterative statements as well as recursive functions using modular programming approach possibly as a team maintaining proper ethics of collaboration.

CO4: Explain and organize data in arrays, strings and structures and manipulate them through programs and also define pointers of different types and use them in defining self-referential structures and also to construct and use files for reading and writing to and from leading to solution of engineering and mathematical problem.

CO5: Prepare laboratory reports on interpretation of experimental results and analyze it for validating the same maintaining proper ethics of collaboration.

CourseContent:

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 Codeblock.

Module-2: Problem based on

a) Basic data types
b) Different arithmetic operators.
c) Print f () and scan f () functions.

Module-3: Problem based on conditional statements using

a) if-else statements
b) different relationaloperators
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 I-Dand2-D).**
b) How to pass an **array** to a **function.**

Module-7: Problem based on manipulation of strings in different way.

Module-8: Problem based on

a) Howto handle compound variables in C
b) How to handle file in C
c) How to use command line argument in C

Textbook:

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

ReferenceBooks:

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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

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

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2nd Year 3rd Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Basic Science course	M 301	Mathematics III	3	0	0	3	3
2	Engineering Science Courses	EC(BME)301	Analog Electronics & Circuit Theory	3	0	0	3	3
3	Program Core Course	BME 301	Human Anatomy and Physiology	3	0	0	3	3
4	Program Core Course	BME 302	Biophysical Signals & Systems	3	0	0	3	3
5	Program Core Course	BME 303	Biomechanics I	3	0	0	3	3
6	Humanities and Social Sciences including Management courses	HSMC 303	Universal Human Values 2: Understanding Harmony	3	0	0	3	3
B. PRACTICAL								
7	Engineering Science Courses	CS 391	Numerical Methods lab	0	0	3	3	1.5
8	Engineering Science Courses	EC 391	Analog Electronics and Circuit Theory Lab	0	0	3	3	1.5
9	Program Core Course	BME 391	Human Anatomy and Physiology Lab	0	0	3	3	1.5
10	Program Core Course	BME 392	Biophysical Signals & Systems Lab	0	0	3	3	1.5
11	PROJECT	PR391	Theme based Project III	0	0	1	1	0.5
12	PROJECT	PR392	Skill Development III: Technical Seminar Presentation	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 301	Environmental Science	3	0	0	3	3 Units
TOTAL CREDIT WITHOUT MOOCS COURSES								**25.0**
D.MOOCS COURSES**								
14	MOOCS COURSES	HM301	MOOCS COURSE-I	1	3	1	4	4
TOTAL CREDIT WITH MOOCS COURSES								**29.0**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MATHEMATICS- III
COURSE CODE: M (BME) 301
CONTACT HOURS: 3-0-0
TOTAL CONTACT HOURS: 36
CREDIT: 3

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

Course Outcome:

CO1: Recall the basic properties related to partial differential equation, probability distribution and statistics.

CO2: Determine the solution of partial differential equation and the problems related to probability distribution and statistics.

CO3: Apply the appropriate mathematical tools of partial differential equation, probability distribution and statistics for the solutions of the problems associated with Bio Medical Engineering.

CO4: Analyze different Bio Medical Engineering problems linked with probability distribution and statistics.

Course Content:

Module I: 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, TwoDimensional Laplace Equation.

Module II: Probability Distribution **10L**

Random Variable: Discrete and Continuous, Probability Distribution, Probability Mass Function and Probability Density Function for single variable only, Distribution Function, Expectation and Variance. Special Types of Distributions: Binomial, Poisson and Normal.

Module III: Statistics: **20L**

Measures of Central Tendency: Mean, Median, Mode.
Measures of Dispersion: Range, Mean deviation, Variance, Standard deviation.
Correlation: Bivariate Data, Scatter Diagram, Methods of studying correlation – Karl-Pearson's coefficient of correlation.

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Regression: Regression lines, Regression equations, Regression coefficients.

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 theoremand related problems.

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.

Testing of Hypothesis: Simple and Composite hypothesis, Critical region, Level of significance, Type I and Type II errors, one sample and two sample tests for means and proportions, $\chi 2$ - test for goodness of fit.

Project Domains:

1. Application of PDE.
2. Analysis of historical data for prediction of drug activity.
3. Application of Statistical techniques for the relevant field of Bio-medical Engineering.
4. Mathematical modeling of an artificial organ and its functionality.

Text Books:

1. M D Raisinghania: Advanced Ordinary & Partial Diff.Equation; S. Chand Publication.
2. N.G. Das: Probability and Statistics; The McGraw Hill Companies.
3. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics; Sultan Chand & Sons.
4. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
5. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics; The World Press Pvt. Ltd.

Reference Books:

1. Boyce, W. E. & DiPrima, R. C.: Elementary Differential Equations and Boundary Value Problems, 9th Edition; Wiley India, 2009.
2. Kreyszig, E., Advanced Engineering Mathematics, 9thEdition; John Wiley & Sons, 2006.
3. Lipschutz & Lipson, Schaum’s Outline in Probability (2ndEd.); McGraw Hill Education.
4. Colburn: Fundamentals of Probability and Statistics; Wiley Publications.
5. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series); McGraw Hill Book Co.
6. Montgomery, D.C. & Runger, G.C. Applied Statistics and Probability for Engineers, Wiley Publications.

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	2	2	-	-	-	-	-	-	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	1
CO3	2	2	-	-	-	-	-	-	-	-	-	2
CO4	2	2	1	-	-	-	-	-	-	-	-	2

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ANALOG ELECTRONICS & CIRCUIT THEORY
COURSE CODE: EC (BME) 301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Properties of series and parallel connections, complex algebra, DC and AC, Charging and discharging of capacitor, Fundamentals of electricity, Ohm's Law

Course Outcome:

CO1: Students able to determine current, voltage and power at different branch for DC and AC circuit using various networks theorems and methods to analyze biomedical signal.

CO2: Study diode and transistor and their application to design various biomedical models.

CO3: Learn how operational amplifiers are modelled and analyzed, and to design OP-AMP circuits to perform operations.

CO4: Study the concepts of both positive and negative feedback in electronic circuits to solve practical problems in biomedical engineering.

Course Content:

Module I: Circuit Theory **8L**

Series and Parallel resonance, Impedance & Admittance Characteristics, Practical resonant circuits, Solution of Problems. Definition and Implication of Superposition Theorem, Thevenin's theorem, Norton's theorem, numerical problems, Kirchhoff's law – KCL and KVL and their applications, transient response.

Module II: Semiconductor and Diode **8L**

Conductors, Insulators, and Semiconductors- crystal structure, Fermi level, Energy band diagrams, intrinsicand extrinsic (p- type and n-type) semiconductors, P-N junction formation and depletion region, current through p-n junction at forward and reverse bias, V-I characteristics of diode, p-n junction breakdown – conditions, avalanche and Zener breakdown, application of Zener diode in regulator circuit.
Diode half wave and full wave rectifiers circuits and operation, (Idc, Irms , Vdc , Vrms, ripple factor without filter, efficiency ,PIV; Reduction of ac ripples using filter circuit)

Module III: Bipolar Junction Transistor: **10L**

Formation of PNP/NPN Transistors, CE, CB, CC configurations, current gain α, β.

Biasing and bias stability; biasing circuits - fixed bias; voltage divider bias; D.C. load line and Quiescent point, calculation of stability factors for different biasing circuits.

BJT as an amplifier and as a switch – Graphical analysis; Numerical Problems.

RC coupled amplifier, functions of all components, High frequency model of transistors (hybrid-π model)

Power Amplifiers: Class A, B, Tuned amplifier.

Basic working principle of JFET and MOSFET

Module IV: Feedback Operation **10L**

Feedback Amplifiers: Feedback concept, negative & positive feedback,

Operational amplifier –ideal characteristics, Non ideal characteristics of op- amp, Configuration of inverting and non-inverting amplifier using Op-amp, Concept of virtual ground, Applications of OP-AMP – summing amplifier; differential amplifier; basic differentiator and integrator.

Oscillators: Barkhausen criterion, RC Oscillators-Phase shift, crystal

Text Books:

1. A. Chakrabarti - Circuit Theory: Analysis and Synthesis, Dhanpat Rai & Co.
2. Valkenburg M. E. Van, “Network Analysis”, Prentice Hall/Pearson Education
3. Roy Chowdhury -Networks and Systems, New Age International
4. Chattopadhyay, P. C. Rakshit, Electronics Fundamentals and Applications, New Age International Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
5. Sedra & Smith, Microelectronics Engineering

Reference Books:

1. B.L. Thereja and A.K. Thereja - A Textbook of Electrical Technology: Basic Electrical Engineering in S. Units (Volume - 1), S-Chand
2. John D. Ryder, Electronic Fundamentals and Applications, PHI 2.J.B. Gupta, Basic Electronics, S.K. Kataria.
3. Malvino: Electronic Principle.
4. Boyelstad & Nashelsky: Electronic Devices & Circuit Theory, McGraw Hill, 1976.

CO – PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: HUMAN ANATOMY & PHYSIOLOGY
COURSE CODE: BME 301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic knowledge of Physiology.

Course Outcome:

After completion of this course students will be able to

CO1: Identify and get an in-depth understanding of anatomy and physiology of the cardiovascular system (heart and blood vessel), the pulmonary system (lung), the renal system, the digestive system, the nervous system, the muscular system and the skeletal system.

CO2: Apply knowledge to comprehend and explain the corresponding structure function relationship of these physiological systems, the mechanisms of function, integration and homeostasis involved in physiological parameters and energy balance.

CO3: Analyze the Structure – Function relations of various human organ systems, to arrive at suitable conclusions to identify problems related to deformity or deviation from normal physiological processes in living systems.

CO4: Interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

Course content

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. Hemoglobin – functions, compounds and derivatives. Abnormal hemoglobin-overview. Erythrocyte sedimentation rate (ESR) and its significance. Hematocrit. 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 & functions of blood vessels (artery, vein, capillary). Differences between artery & vein.

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

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

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Module- 3: Muscular & 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 fibers. 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 & fast muscle fibers, Isotonic & 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 & Histology of Nephron & 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 &Carbondioxide Transport in Human Body.

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

Overview of Nervous system- CNS, PNS, ANS, Structure and function of neurons. Types of nerve fibers. 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 & Wilson, Churchill Livigstone publications.
3. Modern Physiology & Anatomy for Nurses - J Gibson, Black-well Scientific Publishers.

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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	-	1	1	-	-	-	-	-	-	-
CO3	3	3	-	3	2	-	-	2	2	-	-	-
CO4	2	2	2	2	1	2	2	2	2	2	-	2

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOPHYSICAL SIGNALS & SYSTEMS
COURSE CODE: BME 302
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

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

Course Outcomes:

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

CO1: Understand mathematical description and representation of continuous and discrete time signals and systems and determine the response of the LTI system and stability of a feedback system.

CO2: Develop input output relationship for linear shift invariant system and understand the convolution operator for systems.

CO3: Understand and resolve the Continuous Time signals in frequency domain using Fourier series & Fourier transforms, including its limitations and need for Laplace transform and use of z-transform to analyze discrete-time signals.

CO4: Understand the applicability of principles of signals & system 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 & 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 & Electronic Measurement & Instrumentation, Dhanpat Rai & Co. (P) Ltd

CO-PO Mapping:

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMECHANICS-I
COURSE CODE: BME 303
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

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

Course Outcomes:

After completion of the course students will be able to

CO1: Understand the fundamentals of mechanics and its application in human system.

CO2: Describe the various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.

CO3: Analyze the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.

CO4: Gain broad working knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.

CO5: Understand the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.

CO6: Understand the various engineering problems associated with solid biomechanics.

Course Content:

Module- 1: Introduction to Biomechanics **5L**

Review of the principles of mechanics, Vector mechanics- Resultant forces of Co-planer & Non-coplaner and Concurrent & 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.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Module- 3: Tissue Biomechanics 7L

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

Module- 4: Movement Biomechanics 4L

Gait analysis, body & limbs: mass & motion characteristics actions, forces transmitted by joints. Joints forces results in the normal & disable human body, normal & 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 & valves) and blood vessels (arteries, arterioles, capillaries & 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 & Shu Chien, Handbook of Bioengineering,
3. Sean P. Flanagan, Flanagan, Biomechanics: A case-based Approach, Jones & 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 & Wilkins, 2010

2. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones & Bartlett Publishers, 2013.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
4. White &Puyator, Biomechanics, Private publication UAE, 2010

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	3	2	3	2	-	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	2	-	-	-
CO4	3	3	2	-	-	-	-	-	2	-	-	-
CO5	3	3	3	2	2	2	-	2	1	-	2	2
CO6	3	3	2	2	-	1	-	-	-	-	-	-

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: UNIVERSAL HUMAN VALUES2: UNDERSTANDING HARMONY

COURSE CODE: HSMC 303

CONTACTS: 3:0:0

TOTAL CONTACT HOURS: 36

CREDITS: 3

Prerequisite: None

Course Outcomes:

On successful completion of the learning sessions of the course, the learner will be able to

CO1: Develop holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

CO2: Cultivate the harmony in the human being, family, society and nature/ existence.

CO3: Strengthen self-reflection.

CO4: Build commitment and courage to act.

Course Content

Module1: Course Introduction- Need, Basic Guidelines, Content and Process for Value Education 8L

Self- Exploration– what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation-as the process for self- exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility-the basic requirements for ful filament of spirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly-A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking -disliking.

Module2: Understanding Harmony in the Human Being- Harmony in Myself! 6L

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the

harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Ensuring healthvs dealing with disease discussion.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship 7L

Understanding values in human-human relationship; meaning of Justice (nine universal values inrelationships) and program for its fulfilment to ensuremutual happiness; Trust and Respect as the foundational values of relationship. Understanding them earning of Trust; Difference between intention and competence. Understanding them earning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order-from family to world family. Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Elicit examples from students' lives.

Module4: Understanding Harmony in the Nature and Existence-Whole existence as Coexistence 8L

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module5: Implications of the above Holistic Understanding of Harmony on Professional Ethics 7L

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems,

c. Ability to identify and develop appropriatetechnologiesandmanagementpatternsforabove productionsystems.

Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order:

a. At the level ofindividual: as socially and ecologically responsible engineers, technologists and managers
b. At the level of society: as mutually enriching institution sand organizations.

Practice Exercises and Case Studies in Practice (tutorial) Sessions to discuss the conduct as an engineer or scientist etc.

Text Books:

1. Human Values and Professional Ethics by RR Gaur, R Sangal, GP Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New AgeIntl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth-by Mohandas Karamch and Gandhi
5. Small is Beautiful-E.F Schumacher.
6. Slow is Beautiful- Cecile Andrews
7. Economy of Permanence- JC Kumarappa
8. Bharat Mein Angreji Raj- Pandit Sunderlal
9. Rediscovering India-by Dharampal
10. Hind Swaraj or Indian Home Rule-by Mohan das K. Gandhi
11. India Wins Freedom- Maulana Abdul Kalam Azad
12. Vivekananda- Romain Rolland (English)
13. Gandhi-Romain Rolland (English)

CO-PO Mapping:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: NUMERICAL METHODS
COURSE CODE: CS391
CONTACT HOURS: 0-0-3
CREDITS: 1.5

Prerequisite: The students to whom this course will be offered must have the concept of basic numerical techniques and introductory knowledge of any programming language.

Course Objectives:

The objective of this course is to provide basic programming skills for solving the problems in numerical methods. Students will gain a deeper understanding of its relevance and application to medical science.

Course Outcome:

CO1: Recall the theoretical workings of numerical techniques.

CO2: Execute basic command and scripts in a mathematical programming language.

CO3: Apply the programming skills to solve the problems using multiple numerical approaches.

CO4: Analyze if the results are reasonable, and then interpret and clearly communicate the results.

Course Content:

List of Experiment:

1. Write a programme on Newton forward interpolation method.
2. Write a programme on Newton backward interpolation method.
3. Write a programme on Lagrange's interpolation method.
4. Write a programme on Trapezoidal rule for on numerical integration.
5. Write a programme on Simpson's one-third rule for on numerical integration.
6. Write a programme on Weddle's rule for on numerical integration.
7. Write a programme on Euler's method for ordinary differential equation having initial condition.
8. Write a programme on modified Euler's method for ordinary differential equation having initial condition.
9. Write a programme on Runge-Kutta method for ordinary differential equation having initial condition.

10. Write a programme on Bisection method for finding root of algebraic and transcendental equation.
11. Write a programme on Regula-Falsi method for finding root of algebraic and transcendental equation.
12. Write a programme on Newton Raphson method for finding root of algebraic and transcendental equation.

Text/ Reference Books:

1. Mollah, S. A, Numerical Analysis and Computational Procedures, Books and Allied (P) Ltd.
2. Dey, Sukhendu, Gupta Sisir, Numerical Methods, McGraw Hill Education (India) Private Limited.
3. Jain, M. K., Iyengar, S. R. K., Jain, R. K., Numerical Methods, New age International Publishers.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	2	1	-	-	-	-	-	-	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	3	2	3	-	-	-	-	-	-	-	1

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ANALOG ELECTRONICS & CIRCUIT THEORY LAB
COURSE CODE: EC (BME) 391
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: The fundamentals of electricity, active and passive components, basic electronics laws like Ohm's law.

Course Outcome:

CO1: Students able to Students able to analyze series & parallel resonance circuit and transient response in RC, RL and RLC circuit using MATLAB tools

CO2: Knowledge of Electronic components such as Resistors, Capacitors, Diodes, Transistors measuring equipment like DC power supply, Multimeter, CRO, Signal generator, DC power supply.

CO3: Analyze the characteristics of Junction Diode, Zener Diode, BJT & FET and different types of Rectifier Circuits.

CO4: Able to know the application of Diode, BJT & OPAMP.

List of Experiment:

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, measuring and testing equipment like CRO, Signal generators etc.
2. Verification of Network Theorems
3. Transient Response in R-L & R-C Networks; simulation / hardware.
4. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs.
7. Study of I-V characteristics of Field Effect Transistors.
8. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders
10. Study of OPAMP circuits: Integrators and Differentiators.
11. Study on Gain calculation of RC coupled amplifier
12. Innovative Experiments

Curriculum & Syllabus for B.Tech
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Under Autonomy

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Text Books:

H. Chattopadhyay, P. C. Rakshit, Electronics Fundamentals and Applications, New Age International

1. Millman & Halkias, Integrated Electronics, Tata McGraw Hill. 3.Sedra & Smith, Microelectronics Engineering

Reference Books:

1. John D. Ryder, Electronic Fundamentals and Applications, PHI
2. J.B. Gupta, Basic Electronics, S.K. Kataria.
3. Malvino: Electronic Principle.
4. Boyelstad & Nashelsky: Electronic Devices & Circuit Theory, McGraw Hill, 1976.

CO – PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: HUMAN ANATOMY & PHYSIOLOGY LAB
COURSE CODE: BME 391
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Basic knowledge of Biology (Physiology Section)

Course Outcome:

After completion of this course students will be able to

CO1: Identify, understand and explain fundamentals of organ structure at the cellular, tissue, organ, & system levels.

CO2: Apply knowledge of science and engineering fundamentals to get hands on exposure of the gross & microscopic approach to Anatomy & Physiology of various organs.

CO3: Perform logical analysis of results, with all necessary lab tools through experiments to arrive at suitable conclusions to physiological problems that promote the critical understanding of the structure function relationship of human systems.

CO4: Conduct and design experiments using modern engineering tools and instruments to demonstrate and interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

CO5: Function effectively as an individual, and as a member in a team to conduct experiments, interpret results, maintain Physiology Practical ethics, and understand the responsibilities and norms 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 & vein), Skin, Tongue, Liver.
3. Hemoglobin estimation.
4. Determination of blood pressure.
5. Blood film making & 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) & Clotting Time (CT).
9. DC of WBC.
10. Innovative experiments.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO – PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOPHYSICAL SIGNALS & SYSTEMS LAB
COURSE CODE: BME 392
CONTACT: 0:0:2
CREDIT: 1

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

Course Objectives:

The primary objective of this course is to provide a thorough understanding and analysis of signals and systems using MATLAB.

Course Outcomes:

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

CO1: Represent & classify signals, Systems & identify LTI systems using MATLAB.

CO2: Derive Fourier series and Fourier transform for different signals using MATLAB.

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

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

CO5: Understand probability concepts to find statistical properties (mean, variance, auto correlation function) of random variables 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 &HPF, band-pass and reject filters using RC circuits
9. Innovative experiments

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	-	-	2	1	2	2
CO2	2	2	2	3	-	2	-	-	2	1	2	2
CO3	3	3	3	3	-	2	-	-	2	1	2	2
CO4	-	2	3	3	1	2	2	-	2	1	2	2
CO5	-	3	3	3	3	2	-	2	2	2	3	2

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Second Year Fourth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Basic Science course	PH (BME) 401	Physics-II	3	0	0	3	3
2	Engineering Science Courses	EC (BME)402	Digital Electronics & Devices	3	0	0	3	3
3	PC	BME 401	Biomaterials	3	0	0	3	3
4	PC	BME 402	Biomechanics II	3	0	0	3	3
5	PC	BME 403	Bioelectrical & Bioelectronic Measurement	3	0	0	3	3
6	Humanities and Social Sciences including Management courses	HSMC 402	Gender Culture and Development	2	0	0	2	2
B. PRACTICAL								
7	Engineering Science course	PH (BME) 491	Physics-II lab	0	0	2	2	1
8	Engineering Science Courses	EC (BME)402	Digital Electronics & Devices Lab	0	0	3	3	1.5
9	PC	BME 491	Biomaterials Lab	0	0	3	3	1.5
10	PC	BME 492	Biomechanics Lab	0	0	3	3	1.5
11	PROJECT	PR 491	Theme based Project IV	0	0	1	1	0.5
12	PROJECT	PR492	Skill Development IV: Soft Skill & Aptitude-I	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 481	Environmental Protection Initiatives OR Learning an Art Form [vocal or instrumental, dance, painting, clay modeling, etc.]	0	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.5**
D.MOOCS COURSES								
14	MOOCS COURSES	HM401	MOOCS COURSE-II	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.5**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

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COURSE NAME: PHYSICS-II
COURSE CODE: PH (BME) 401
CONTACTS: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of Physics up B. Tech 1st year Physics-I course

Course Outcome

After completion of this course student will be able to

CO1: explain the action of various types of microscopes, imaging and radioactive systems.

CO2: apply Schrödinger equation in variety of atomic scale problems including nanomaterials.

CO3: analyze the physics of various kinds of electric and magnetic materials

CO4: justify the importance of ultrasonic sound in biomedical engineering

Course Content:

Module 1: Electric and Magnetic properties of materials **12L**

Module 1.01: Insulating materials:

Dielectric Material: Concept of Polarization, the 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 piezoelectric (Qualitative study) **5L**

Module 1.02: Magnetic materials and storage devices:

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.) **5L**

Module 1.03: Super conductivity: Basic concept, qualitative study up to Meissner effect, examples of High Temperature Superconductor, BCS theory (qualitative), Applications in Biomedical Engineering. **2L**

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Module 2: Ultrasound (4L)

Ultrasound-Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering & Medical applications of Ultrasonics (Non-destructive testing, cavitation, measurement of gauge) **Infrasound** – Introduction and definition, production, application, **4L**

Module 3: Display, Optical Instruments & opto-electronic devices 10L

3.01: Electron Optics: Operation and application of CRT (AC), Physics of Liquid crystal display (LCD), LED **4L**

3.02: Optical Instruments: Imaging-Types of imaging (PET, CT), electron microscope. **4L**

3.03: Radiation therapy-radio activity, doses, strength, applications. **3L**

Module 4: Quantum Mechanics-II 7L

Formulation of quantum mechanics and Basic postulates- superposition principle, orthogonality of wave function, expectation value; operator correspondence, Commutator. Measurements in Quantum Mechanics-Eigen value, Eigen function, Schrödinger's equation as energy eigen value equation. **4L**

Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only $E<V_0$). **3L**

Module 5: Physics of Nanomaterials 3L

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, grapheme, electronic, environment, medical). **3L**

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

6. Quantum Mechanics- Bagde Singh (S. Chand Publishers)
7. Principles of Engineering Physics Vol 1 and Vol 2; by Md. N. Khan and S. Panigrahi, Pub: Cambridge Univ. press
8. Advanced Quantum Mechanics-J. J. Sakurai (TMH)
9. Quantum Computation and Quantum Information (10th Anniversary Edition)- Nielsen & Chuang (Cambridge University Press)
9. Fundamental of Statistical Mechanics: B Laud
10. Introduction to statistical mechanics: Pathria
11. Fundamental of Statistical and Thermal Physics: F. Reif Advanced Engineering Physics-S. P. Kuila New
Central Book Agency (P)Ltd.
12. Electricity and Magnetism (In Si Units): Berkeley Physics Course - Vol.2, Edward M Purcell
13. Introduction to Electrodynamics-Griffiths David J.
14. The Feynman Lectures on Physics. 2 (2nd ed.)., Feynman, Richard P Addison-Wesley. ISBN 978-0-8053-9065-0
4. Solid State Physics, A. J. Dekker, McMillan
15.Nanostructure and Nanomaterials, B.K. Parthasarathy
16.Introduction to Nanotechnology, B.K. Parthasarathy
17.Essentials of Nanotechnology, Rishabh Anand
18.Nanomaterials Handbook (Advanced Materials and Technologies)-Yury Gogotsi (Editor) 1. Nuclear Physics,
Irvin Keplan
19. Nuclear Physics, J. Pearson, University of Manchester, 2008
20. Nuclear and Particle Physics, Jenny Thomas - University College London, 2000.
21. 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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

Prerequisite: Mathematics, BasicElectronics Engineering

Course Outcome

After the course, students will be able to

CO1: Understand and describe/explain 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 & 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 & 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 & 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.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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 & Smith-Microelectronic Circuits- Oxford UP
2. Boylested & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
3. S. Salivahanan, S. Aribazhagan, Digital Circuit & 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 & 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 & Malvino—Digital Principles & Application, 5/e, McGraw Hill
6. H. Taub & D. Shilling, Digital Integrated Electronics- McGraw Hill.

CO-PO MAPPING

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMATERIALS
COURSE CODE: BME 401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

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

Course Outcome:

After completion of this course students will be

CO1: Identify and understand the fundamental concepts in material science (e.g., atomic structure and bonding, crystalline structures and defects) and interpretation of phase diagrams.

CO2: Apply a broad knowledge of different types of biomaterials including metals, polymers, ceramics and composites and their use in typical biomedical implants, devices and clinical applications.

CO3: Design an implant using fundamental concept and modern engineering tools by suitable material selection conforming to standards.

CO4: Analyze the basic design of various biocompatible implants to develop and improve Health Care Service to serve mankind and society.

CO5: Demonstrate an understanding of standards, regulations, ethical responsibilities and possible hurdles in the process of developing biomaterials in bringing a product to market.

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

Definition of biomaterials, requirements & 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.

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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 bioceramics, Common types of bioceramics: Aluminum oxides, Glass ceramics, Carbons.Bio-inert Ceramics: Alumina, Carbon, Zirconia; Biodegradable Ceramics: Tri-Calcium phosphate, Aluminum-Calcium-Phosphate (ALCAP) Ceramics; Bioactive ceramics: Bioglass, Hydroxyapetite, 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- Hydroxyapetite), Clinical Applications.

Module- 6: Biocompatibility & 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, haemolysis, 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

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

2. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
3. C.P. Sharma & 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 & E. C. Ethridge, *Biomaterials - An Interfacial approach*.\
7. Frederick H. Silver, Biomaterials, Medical devices and Tissue Engineering, Chapman & Hall.

CO-PO Mapping:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMECHANICS- II
COURSE CODE: BME 402
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

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

Course Outcome:

After completion of the course student will be able to

CO1: Describe the basic principles of fluid mechanics and its application in physiological system.

CO2: Understand various engineering aspects of fluid flow in human body, primarily related to blood flow in the heart and blood vessels.

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

CO4: Apply engineering concepts of fluid mechanics to understand real-life biological flow.

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 & 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 & 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, Taylor&Francis 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.

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOELECTRICAL & BIOELECTRONICS MEASUREMENT
COURSE CODE: BME 403
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

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

Course Outcome:

After completion of this course student will be able to

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

CO2: Describe the measurement of bio-potentials using different types of electrodes and procedure.

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 throughion exchange, Chemical balances, force balances, general bioelectrical potentialbalances, Kirchhoff's laws, Conservation of mass & 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.

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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 nanoconductors: 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 ofintensive care monitoring, Patient monitoring displays, Multi-parameterMonitoring Device, Automated Diagnosis of Bioelectrical Signals.

Text Books:

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

Reference Books:

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

CO-PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: GENDER, CULTURE AND DEVELOPMENT
COURSE CODE: HSMC 402
CONTACTS: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 2

Prerequisite: None

Course Outcomes:

On successful completion of the learning sessions of the course, the learner will be able to

CO1: Provide an analysis of the location of women in the processes of economic development; to understand what economic development is, the scales or levels at which it occurs, and the centrality of gender at every level.

CO2: Examine theoretical and conceptual frameworks for that analysis.

CO3: Reflect upon linkages between the global economy and the gendered macro and micro process of development and transitions from 'government' to 'governance.'

CO4: Explain the usefulness of a rights-based approach to gender justice.

CO5: Provide basis for research, practical action and policy formulation and or evaluating for evaluating directions and strategies for social change from a gender perspective.

Course Content

Module1:

Introduction to Gender, Definition of Gender, Basic Gender Concepts and Terminology, Exploring Attitudes towards Gender, Social Construction of Gender **4L**

Module 2:

Gender Roles and Relations, Types of Gender Roles, Gender Roles and Relationships Matrix, Gender-based Division and Valuation of Labour **6L**

Module 3:

Gender Development Issues, Identifying Gender Issues, Gender Sensitive Language, Gender, Governance and Sustainable Development, Gender and Human Rights, Gender and Mainstreaming. **5L**

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Module 4:

Gender-based Violence, The concept of violence, Types of Gender-based violence, The relationship between gender, development and violence, Gender-based violence from a human rights perspective. **5L**

Module5:

Gender and Culture Gender and Film, Gender and Electronic Media, Gender and Advertisement, Gender and Popular Literature. **4L**

Text Books:

1. Beneria, Lourdes. (2004). Gender, Development, and Globalization: Economics as if All People Mattered. Roultedge Press. (GDGE)
2. Molyneux and Razavi. (2002). Gender Justice, Development and Rights. Oxford University Press (GJDR or WGD)
3. Visvanathan, Duggan,Wiegersma and Nisonoff. (2011). The Women, Gender and Development Reader. 2nd Edition. Zed Press (WGD)

CO-PO Mapping

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

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: PHYSICS- II LAB
COURSE CODE: PH (BME) 491
CONTACT: 0:0:2
CREDIT: 1
Prerequisite: Knowledge of Physics up B. Tech 1st year Physics-I course

Course Outcome

At the end of the course students' will be able to

CO1: Demonstrate experiments allied to their theoretical concepts

CO2: Conduct experiments using semiconductors, dielectric and ferroelectrics, ultrasounds

CO3: Classify various types of magnetic materials

CO4: Participate as an individual, and as a member or leader in groups in laboratory sessions actively

CO5: Analyze experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiments.

List of Experiment:

***At least 7 experiments to be performed during the semester**

Experiments on Module 1: Electric and Magnetic properties of materials

1. Study of dipolar magnetic field behavior using deflection magnetometer.
2. Study of hysteresis curve of a ferromagnetic material using CRO.
3. Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
4. Measurement of Curie temperature of the given sample.
5. Determination of dielectric constant of given sample (frequency dependent)

Experiments on Module 2: Ultrasound

6. Determination of velocity of ultrasonic wave using piezoelectric crystal.

Module 3: Display, Optical Instruments & opto-electronic devices

7. Measurement of specific charge of electron using CRT.

Experiments on Module 4: Quantum Mechanics-II

8. Determination of Stefan's radiation constant.
9. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.

10. Determination of band gap of a semiconductor.

11. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor

12. Study of I-V characteristics of a LED.

13. Study of I-V characteristics of a LDR

****In addition to regular 7 experiments 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. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.

2. Determination of thermal conductivity of a good conductor by Searle's mothod.

3. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.

CO-PO Mapping:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DIGITAL ELECTRONICS & DEVICES LAB
COURSE CODE: EC (BME) 492
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic Electronics Engineering

Course Outcome

After the course, students will be able to:

CO1: Explain 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: Describe, analyse, formulate and construct 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	-	2	-	-	2	3
CO2	3	3	1	-	2	1	2	-	3	1	-	3
CO3	3	2	2	2	-	3	-	1	-	2	3	3
CO4	3	-	1	-	2	3	2	-	2	-	-	3

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMATERIALS LAB
COURSE CODE: BME 491
CONTACT: 0:0:3
CREDITS: 1.5

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

Course Outcome:

After completion of this course, students will be able to

CO1: Characterize 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 test 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMECHANICS LAB
COURSE CODE: BME 492
CONTACT: 0:0:3
CREDIT: 1.5

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

Course Outcome:

After completion of this course, students will be able to

CO1: Understand linear and angular descriptors of human motion (kinematics) and quantifythe forces associated with human movement (kinetics).

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

CO3: Use precise, well-defined mechanical and anatomical terminology to describe the body movement and explain the Gait variables.

CO4: Explain human movement through an understanding of biomechanical principles

CO5: Design and perform tapping torque tests (TTT) according to the ASTM standard.

List of Experiments:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

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

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Third Year Fifth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	**T**	**P**	**Total**	
A. THEORY								
1	Humanities and Social Sciences including Management courses	HSMC 505	Principles of Management	2	0	0	2	2
2	PC	BME 501	Biomedical Instrumentation	3	0	0	3	3
3	PC	BME 502	Biosensors & Transducers	3	0	0	3	3
4	PC	BME 503	Medical Imaging Systems I	3	0	0	3	3
5	PE	BME 504A BME 504B BME 504C	Communication & Biotelemetry Modelling of Physiological Systems Biomedical Informatics	3	0	0	3	3
6	OE	BME 505A BME 505B BME 505C	Data Structure & Algorithm VLSI & Embedded System Measurements and Control Systems	3	0	0	3	3
B. PRACTICAL								
7	PC	BME 591	Biomedical Instrumentation Lab	0	0	3	3	1.5
8	PC	BME 592	Biosensors & Transducers Lab	0	0	3	3	1.5
9	OE	BME 595A BME 595B BME 595C	Data Structure & Algorithm Lab VLSI & Embedded System Lab Measurements and Control Systems Lab	0	0	3	3	1.5
10	PROJECT	PR 591	Minor Project I	0	0	3	3	1
11	PROJECT	PR 592	Skill Development V: Soft Skill & Aptitude-II	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
12	MC	MC 501	Constitution of India	3	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D. MOOCS COURSES**								
13	MOOCS COURSES	HM501	MOOCS COURSE-III	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**27.0**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: PRINCIPLES OF MANAGEMENT
COURSECODE: HSMC 505
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 2

Prerequisites: Nil

Course outcome:

After completion of the course students will be able to

CO1: Recall and identify the relevance of management concepts.

CO2: Apply management techniques for meeting current and future management challenges faced by the organization

CO3: Compare the management theories and models critically to solve real life problems in an organization.

CO4: Apply principles of management in order to execute the role as a manager in an organization.

Course Content

Module- 1: Management Concepts **4L**

Definition, roles, functions and importance of Management, Evolution of Management thought-contribution made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow.

Module- 2: Planning and Control **4L**

Planning: Nature and importance of planning, -types of planning, Levels of planning - The Planning Process. – MBO, SWOT analysis, McKinsey's7S Approach.

Organizing for decision making: Nature of organizing, span of control, Organizational structure –line and staff authority.

Control: Basic control process, control as a feedback system, Feed Forward Control, Requirements for effective control.

Module- 3: Group dynamics & Leadership **4L**

Group dynamics: Types of groups, characteristics, objectives of Group Dynamics.

Leadership: Definition, styles & functions of leadership, qualities forgood leadership, Theories of leadership.

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Module- 4: Work Study and work measurement **4L**

Definition of work study, Method Study Steps, Tools and Techniques used in the Method Study and Work Measurement Time Study: Aim & Objectives, Use of stopwatch procedure in making Time Study. Performance rating, allowances and its types. Calculation of Standard Time. Work sampling.

Module- 5: Marketing Management **2L**

Functions of Marketing, Product Planning and development, Promotional Strategy.

Module- 6: Quality management **6L**

Quality definition, Statistical quality control, acceptance sampling, Control Charts –Mean chart, range chart, cchart, pchart, np chart, Zero Defects, Quality circles, , Kaizen & Six Sigma ,ISO - 9000 Implementation steps, Total quality management.

Text Books:

1. Essentials of Management, by Harold Kooritz & Heinz Weihrich Tata McGraw
2. Production and Operations Management-K. Aswathapa, K .Shridhara Bhat, Himalayan Publishing House

Reference Books:

1. Organizational Behavior, by Stephen Robbins Pearson Education, New Delhi
2. New era Management, Daft, 11th Edition, Cengage Learning
3. Principles of Marketing, Kotlar Philip and Armstrong Gary, Pearson publication

CO – PO Mapping

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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMEDICAL INSTRUMENTATION
COURSECODE: BME 501
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of Analog & Digital electronics

Course Outcome:

After completion of this course students will be able to

CO1: Characterize 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 &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 & Computers in medical instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.

Module- 2: MeasurementSystems 6L

Specifications of instruments, Static & 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&ITU.

TextBooks:

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

ReferenceBooks:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg. ,Boston. J.Webster, "Bioinstrumentation", Wiley& 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	2	3	-	1	2	-	-	-	-	-	-	-
CO2	3	3	2	1	1	-	1	-	-	-	-	1
CO3	3	2	-	2	1	1	-	-	-	-	-	-
CO4	3	3	3	2	2	2	2	2	-	-	-	2

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOSENSORS & TRANSDUCERS
COURSE CODE: BME 502
CONTACT: 3:0:0
CONTACT HOURS: 36
CREDITS: 3

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

Course Outcome:

After completion of this course students will be able to

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

CO2: Understand the concepts, types, working and practical applications ofimportant biosensors, electrodes for acquiring and recording various physiological parameters.

CO3: Gain broad knowledge on the mechanisms which govern the acquisition and processing of physiological signals recorded from a human subject, both *invivo* and *invitro*.

CO4: Apply the concept of enzyme specific interaction for biosensor development.

CO5: Compare different techniques with emphasis on sensitivity & selectivity and critically evaluate a selected application of a biosensor.

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 & 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 & 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 & BIOMEMS, basic idea about Smart sensors.

Text Books:

1. R. S. Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill.
2. S.C. Cobbold, “Transducers for Biomedical Instruments”, Prentice Hall.
3. Rao & Guha, Principles of Medical Electronics & Biomedical Instrumentation, University Press, India.
4. Carr& Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

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Reference Books:

1. Iberall & Guyton, Regulation & Control in Physiological System, Instruments Soc.USA.
2. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.
3. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
4. 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	2	2	2	-	1	1	-	-	1	-	1
CO2	2	3	2	2	2	1	2	2	1	2	2	1
CO3	3	3	2	1	2	2	-	-	2	2	-	2
CO4	3	2	2	2	3	-	2	2	-	-	3	2
CO5	3	3	3	2	2	2	2	-	2	1	2	2

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEDICAL IMAGING TECHNIQUES
COURSECODE: BME 503
CONTACT: 3:0:0
TOTAL CONTACTHOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Physics and Medical Instruments.

Course Outcome:

After completion of this course students will be able to

CO1: Understand the physics & principles behind the operations of different medical imaging equipment under different modalities.

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

CO3: Identify and 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.

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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.

TextBooks:

1. Carr& 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 &Sons

Reference Books:

1. Dowsett, Kenny& Johnston, “The Physics of Diagnostic Imaging”, Chapman& Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, “Medical Physics and Biomedical Engineering”, Institute of Physics Publishing, Bristol.
3. Massey& Meredith, “Fundamental Physics of Radiology”, John Wright & 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	-	2	-	1	-	1	-	-	-	-
CO2	2	2	2	1	-	3	2	3	-	-	-	-
CO3	2	3	-	2	1	-	1	-	-	-	-	-
CO4	-	3	-	3	2	2	-	-	-	-	-	-

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: COMMUNICATION SYSTEMS & BIOTELEMETRY
COURSE CODE: BME 504A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Mathematics, Digital Electronics, Signal Theory.

Course outcome:

After completion of the course students will be able to

CO1: Define and analyze 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: Solve 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 & 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	2	2	-	-	-	-	-	-	-	-	2
CO2	2	1	-	-	2	-	2	-	-	-	-	-
CO3	-	3	2	2	-	3	-	-	-	3	-	1
CO4	3	2		3	-	-	-	-	-	2	-	-

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COURSE NAME: MODELING OF PHYSIOLOGICAL SYSTEM
COURSE CODE: BME 504B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Human anatomy and physiology, Control system & analysis, Physics, Higher Engineering Mathematics

Course Outcomes:

After completion of the course the students will be able to

CO1: Understand 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: Understand, predict and 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 modeling, classification of models-black box & building block, parametric & non parametric, lumped & distributed models, linear & non-linear, characteristics of models, Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy. Time invariant and time varying systems for physiological modeling.

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.

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Module- 3: Linear Model **4L**

Respiratory mechanics & muscle mechanics, Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & 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 & Bronzino, Introduction to Biomedical Engg., Academic press.
2. Suresh. R. Devasahayam, Signals & 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 & 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	1	-	-	2	1	-	2
CO2	3	2	2	2	3	2	2	2	1	-	2	1
CO3	3	2	2	3	-	-	1	-	-	2	-	1
CO4	3	2	3	2	2	2	-	1	2	-	1	-
CO5	3	2	3	2	2	1	2	2	2	-	2	2

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMEDICAL INFORMATICS
COURSE CODE: BME 504C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

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

Course Outcome:

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

CO1: Understand & demonstrate the bioinformatics database, cellular interaction & process.

CO2: Apply bioinformatics & 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 cell, 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& 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.

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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:

CO	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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DATA STRUCTURE & ALGORITHM
COURSE CODE: BME 505A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: Basic Mathematics, Programming language

Course Outcome:

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, dequeue. 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& 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	-	-	-	-	-	-	-	-

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: VLSI & EMBEDDED SYSTEM
COURSE CODE: BME 505B
CONTACTS: 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 & 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. **5L**

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Module 2: Digital VLSI Circuit Design

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 & J-K Latch, CMOS Clocked SR & JK Latch /Master – slave JK Flip- flop, CMOS D Flip-flop; 6T SRAM cell and 3T DRAM cell design, EEPROM, Flash Memory. **10L**

Module 3: Analog VLSI Circuit Design: 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). **7L**

Module 4: Introduction to Embedded System: 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 **7L**

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

Text Books:

1. Digital Integrated Circuit, J.M. Rabaey, Chandrakasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuits Analysis and Design, S.M.Kang&Y.Leblebici,TMH.
3. CMOS Analog Circuit Design, Allen & 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 & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEASUREMENTS AND CONTROL SYSTEMS
COURSE CODE: BME 505C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites: Concept of Basic Electronics, Laplace Transform.

Course Outcome:

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 behavior 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 & 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.

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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 & 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. Nagrath& M. Gopal. New Age International Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuo& F. Golnaraghi, 8th Edition, PHI
5. A.K.Sawhney, Electrical and Electronics Measurement and Instrumentation, Dhanpat Rai & Co.
6. H.S.Kalsi, Electronic Instrumentation, Tata McGraw Hill.

Reference Books:

1. Control Engineering Theory & 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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMEDICAL INSTRUMENTATION LAB
COURSECODE: BME 591
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisites: Knowledge of Analog & Digital electronics

Course Outcome:

Aftercompletion ofthiscoursethe studentswill beable to

CO1: Understand& describe 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: Analyze 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 Experiment:

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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-P0 Mapping

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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOSENSORS & TRANSDUCERS LAB
COURSE CODE: BME 592
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Fundamentals of sensors and transducers and basic electronics laboratory.

Course Outcome:

After learning the course, the students should able to

CO1: Understand the working principle and characteristics of different types of sensors and transducers useful in medical field.

CO2: Implement different sensors as per their applications in biomedical instrumentation.

CO3: Explain the different diagnostic methods for identification of human bio-potentials and their necessary instrumentation.

CO4: Identify the sensors and transducers applicable for a selected biomedical application.

List of Experiment:

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 & characterization of bio-transducers – Pressure, Temperature, Humidity
10. Study & characterization of bio-electrodes – ECG, EMG, EEG
11. Innovative experiment

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO – PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DATA STRUCTURE & ALGORITHM LAB
COURSE CODE: BME 595A
CONTACT: 0:0:3
CREDITS: 1.5

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 Experiment:

1. Program to Find the Number of Elements in an Array
2. Develop and Implement 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 & display element from single linked list
11. Program to create add remove & display element from double linked list
12. Program to count number of nodes in linear linked list
13. Program to create add remove & display element from circular linked list
14. Programs to implement stack & queues using linked representation
15. Program to concatenate two linear linked lists

16. Program to accept a singly linked list of integers & 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 & deletion in c
20. Program for pre-order, post-order & 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	-	-	-	-

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: VLSI & EMBEDDED SYSTEM LAB
COURSE CODE: BME 595B
CONTACTS: 3P
TOTAL CONTACT HOURS: 20P
CREDITS: 1.5

Prerequisite: Sensors, Actuators, System Integration, Cloud and Network Security

Course Outcomes:

After 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 & Y.Leblebici,TMH.
3. CMOS Analog Circuit Design, Allen &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& 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

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

	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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEASUREMENTS AND CONTROL SYSTEMS LAB
COURSE CODE: BME 595C
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisites: Familiarization with electronic instruments, MATLAB.

Course Outcome:

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 & plot characteristics.
2. To measure displacement by Strain gauge & 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 & Second order system with unity feedback using MATLAB
7. Simulation of Step response & Impulse response for type-0, type-1 & 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.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: CONSTITUTION OF INDIA
COURSE CODE: MC 501
CONTACTS: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 0

Prerequisite: None

Course Outcomes:

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: Introduction: **4L**

"Constitution"- Historical Background of the Constituent Assembly, Indian Constitution and its Salient Features, the Preamble of the Constitution.

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

8L

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

The Directive Principles

Fundamental Duties

Module 3: Union Government and its Administration 6L

Structure of the Indian Union, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 4: The Machinery of Government in the State 6L

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges

State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Text / Reference Books:

1) Indian Constitution by D.D.Basu, The Publisher, LexisNexis
2) Constitution of India by Subhas C Kasyap, Vitasta Publishing
3) The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
4) Indian Constitution Text Book - Avasthi, Avasthi,Publisher: LAKSHMI NARAIN AGARWAL

CO-PO Mapping:

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Third Year Sixth Semester

Sl. No.	Category	Course Code	Course Title	Hours per week				Credits
				L	T	P	Total	
A. THEORY								
1	Humanities and Social Sciences including Management courses	HSMC 604	Economics for Engineers	2	0	0	2	2
2	PC	BME 601	Analytical & Diagnostic Equipment	3	0	0	3	3
3	PC	BME 602	Biosignal Processing	3	0	0	3	3
4	PC	BME 603	Medical Imaging Systems II	3	0	0	3	3
5	PE	BME 604A BME 604B BME 604C	Biophysics & Biochemistry Nanobiotechnology Tissue Engineering	3	0	0	3	3
6	OE	BME 605A BME 605B BME 605C	Database Management System Microprocessor & Microcontroller Soft Computing	3	0	0	3	3
B. PRACTICAL								
7	PC	BME 691	Analytical & Diagnostic Equipment Lab	0	0	3	3	1.5
9	PC	BME 692	Biosignal Processing Lab	0	0	3	3	1.5
10	OE	BME 695	Database Management System Lab Microprocessor & Microcontroller Lab Soft Computing Lab	0	0	3	3	1.5
11	PROJECT	PR 691	Minor Project II	0	0	3	2	1
12	PROJECT	PR 692	Skill Development VI: Soft Skill & Aptitude-III	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
13	MC	MC 601	Intellectual Property Right	3	0	0	3	3Units
	TOTAL CREDIT WITHOUT MOOCS COURSES							**23.0**
D.MOOCS COURSES**								
14	MOOCS COURSES	HM601	MOOCS COURSE-IV	3	1	0	4	4
	TOTAL CREDIT WITH MOOCS COURSES							**27.0**

**** MOOCS COURSES for HONOURS/MINOR Degree are Program specific and to be taken from MOOCS BASKET**

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ECONOMICS FOR ENGINEERS

COURSECODE: HSMC 604

CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDITS: 2

Pre-requisites: MATH – College Algebra, Pre-Calculus Algebra and Trigonometry.

Course Outcome:

CO1: Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, Rate-of-return, payback, break-even, benefit-cost ratio.

CO2: Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

CO3: Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.

CO4: Evaluate the profit of a firm, carry out the break even analysis and employ this tool to make production decision.

CO5: Discuss and solve advanced economic engineering analysis problems including taxation and inflation.

Course Content:

Module- 1: Introduction **2L**

Managerial Economics-Relationship with other disciplines-Firms: Types, Objectives and goals-Managerial Decisions-Decision Analysis.

Module- 2: Demand and Supply Analysis **6L**

Demand-Types of demand-determinants of demand-Demand function -Demand Elasticity-Demand forecasting -Supply-Determinants of supply-Supply function -Supply Elasticity.

Module- 3: Cost Analysis **6L**

Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – PV ratio,

Module- 4: Elementary economic Analysis **4L**

Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

Module- 5: Financial Accounting **4L**

Concepts and Definition of Accounting, Journal, Ledger, Trial Balance. Trading A/C, Profit & Loss A/C and Balance Sheet.

Module- 6: Investment Decision **2L**

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence. Evaluation of engineering projects- Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Text Books:

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India
2. Principles of Economics, Deviga Vengedasalam; Karunagaran Madhavan, Oxford University Press.
3. Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
4. R.Paneer Seelvan, " Engineering Economics", PHI

Reference Books:

1. Ahuja, H.L., "Principles of Micro Economics" , S.Chand & Company Ltd
2. Jhingan, M.L., "Macro Economic Theory"
3. Macro Economics by S.P.Gupta, TMH
4. Haniff and Mukherjee, Modern Accounting, Vol-1, TMG
5. Modern Economic Theory – K.K. Dewett (S.Chand)

CO-PO Mapping:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ANALYTICAL & DIAGNOSTIC EQUIPMENT
COURSECODE: BME 601

CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of Biomedical Instrumentation

Course outcome:

After completion of this course the students will be able to

CO1: Understand the fundamentals of chemical and scientific theories in analytical& diagnostic equipment.

CO2: Interpret 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: Apply 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 & 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, Fibreoptic 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 & J.M. Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
4. Cromwell, Weibell & Pfeiffer, “Biomedical Instrumentation & Measurement”, Prentice Hall, India.

Reference Books:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg . , Boston.
2. J. Webster, “Bioinstrumentation”, Wiley & 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	2	1	1	2	-	-	-	-	-	-	-
CO2	3	3	2	2	1	-	2	-	-	-	-	1
CO3	2	3	-	1	2	2	-	-	-	-	-	-
CO4	2	3	3	2	2	-	-	2	-	-	-	2

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Biomedical Engineering
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOSIGNAL PROCESSING
COURSE CODE: BME 602
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of Biomedical Signal and Systems

Course Outcome:

After completion students will be able to

CO1: Understand the fundamental techniques & applications of digital signal processing with emphasis 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: Design different digital filters using designing prototype to effectively perform BDSP operation.

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 discrete signals.

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.

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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	2	1	1	2	-	-	-	-	-	-	-
CO2	3	3	2	2	3	2	-	-	2	-	-	-
CO3	3	2	3	3	2	1	-	1	-	-	-	-
CO4	3	2	3	3	2	-	-	2	-	-	-	2

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COURSE NAME: MEDICAL IMAGING SYSTEMS II
COURSE CODE: BME 603
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of basic medical imaging techniques

Course outcome:

After completion of this course the students will be able to

CO1: Understand the physics & principles behind the operations of medical imaging equipment used for advanced.

CO2: Gain integrated knowledge of the applications of physical processes to the diagnosis and treatment of disease, including an understanding of contemporary developments in professional practice.

CO3: Identify and analyze 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 & transfer of images: file formats; Radiological Information System, Hospital Information System, Picture archiving and communication systems, internet & intranet, teleradiology, medical image processing system-basic introduction.

Text Books:

1. Carr& 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 & Sons

Reference Books:

1. Dowsett, Kenny & Johnston, “The Physics of Diagnostic Imaging”, Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, “Medical Physics and Biomedical Engineering”, Institute of Physics Publishing, Bristol.
3. Massey & Meredith, “Fundamental Physics of Radiology”, John Wright & 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	-	2	1	1	-	-	-	-	-	1
CO2	2	2	1	1	1	3	2	2	-	1	-	-
CO3	2	3	2	2	3	1	1	-	2	-	2	3
CO4	2	3	-	3	2	1	-	-	2	2	2	3

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COURSE NAME: BIOPHYSICS & BIOCHEMISTRY
COURSE CODE: BME 604A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fundamental Physics & Chemistry, Cell Biology.

Course Outcome:

After completion of this course students will be able to

CO1: Acquire, articulate and retain broad and in-depth knowledge and understanding of the ways by which life functions are explained in terms of the principles of chemistry and physics and fundamental processes of Biochemistry and Biophysics.

CO2: Identify and analyze complex problems related to Formation of Structures in Biological Systems, Structural-Functional Relationships of Nucleic Acid and proteins, Biophysical activity, Radioactivity to arrive at suitable conclusions using first principles of Biophysics and Biochemistry.

CO3: Design, develop and conduct investigations to evaluate and interpret results to solve problems related to Cellular Biochemistry, Biophysical and Biochemical activity.

CO4: Apply appropriate techniques, resources, modern engineering tools to interpret complex biophysical, biochemical and biomolecular activities with an understanding of scientific and moral ethics and environmental concerns and in turn develops an awareness of ethical responsibilities while conducting and reporting investigations in Clinical Science.

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.

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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 & IR radiations, Production of radioisotopes, Radioactive decay, Half-life period.

Module- 5: Macromolecules 8L

Classification & functions of carbohydrate. Glycolysis. TCA cycle. ATP synthesis. Classification & functions of proteins. Architecture of protein. Classification of amino acid. Oxidative and non-oxidative deamination, transamination. Classification & functions of lipids. Biosynthesis of long chain fatty acid. Oxidation and degradation of fatty acid.

Module- 6: Enzymes and Nucleic acid 8L

Chemical nature & 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 & 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 & 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.

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CO – PO Mapping

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

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COURSE NAME: NANOBIOTECHNOLOGY
COURSE CODE: BME 604B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Fundamental knowledge of physics, biochemistry, biomaterials and nano-materials.

Course Outcome:

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 knowledge 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 Nanobiotechnology 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 & 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

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COURSE NAME: TISSUE ENGINEERING
COURSE CODE: BME 604C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge of cell biology, biomaterials

Course Outcome:

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-Nanotemplating 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. KetulPopat*"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	-	-	-	-	-	-	-
CO4	3	2	-	2	2	-	-	-	-	-	-	-

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DATABASE MANAGEMENT SYSTEM
COURSE CODE: BME 605A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge on Mathematics and Basics of Data Structure.

Course Outcome:

After completion of this course student will be able to

CO1: Define Database Management System, explain fundamental elements of a database management system, and compare the basic concepts of relational data model, entity-relationship model.

CO2: 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.

CO3: Criticize a database design and improve the design by normalization.

CO4: Choose efficient query optimization techniques, select suitable transaction management, concurrency control mechanism and Recovery management techniques.

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 Model **3L**

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Module- 3: Relational Model **4L**

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module- 4: SQL and Integrity Constraints **8L**

Concept of DDL, DML, DCL. Basic Structure, Setoperations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers.

Module- 5: 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.

Module- 6: Internals of RDBMS **6L**

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.

Module- 7: File Organization & Index Structures **5L**

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

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. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill.
2. Peter Rob and Carlos Coronel, Database Systesm- Design, Implementation and Management (7/e), Cengage Learning.

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CO-PO Mapping

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

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COURSE NAME: MICROPROCESSORS & MICROCONTROLLERS
COURSE CODE: BME605B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: Knowledge in Digital Electronics

Course Outcome:

CO1: Able to correlate the architecture, instructions, timing diagrams, addressing modes, memory interfacing, interrupts, data communication of 8085

CO2: Able to 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 microprocessor, 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 processor, 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 & smallest number etc.

Module- 4: 8051 Microcontroller **4L**

8051 architecture, 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 & interfacing – D. V. Hall,Tata McGraw-hill
4. Ray & Bhurchandi, Advanced Microprocessors & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: SOFT COMPUTING
COURSE CODE: BME 605C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge on Mathematics, Set theory.

Course outcome:

On completion of this course student will be able to

CO1: Understand the importance of Soft Computing.

CO2: Remember different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.

CO3: Implement algorithms based on soft computing

CO4: Apply soft computing techniques to solve engineering or real-life problems.

Course Content

Module- 1: Introduction **4L**

Soft Computing. Difference between Hard and Soft computing, Requirement of Soft Computing, Major Areas of Soft Computing, Applications of Soft Computing.

Module- 2: Fuzzy Systems **10L**

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Min-max Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

Module- 3: Genetic Algorithm **7L**

History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.

Module- 4: Neural Networks **8L**

Neural Network, Learning rules and various activation functions, Single layer Perceptrons, 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.

Curriculum & Syllabus for B.Tech
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Module- 5: Multi-objective Optimization Problem Solving **4L**

Concept of multi-objective optimization problems (MOOPs) and issues of solving them. Multi-Objective Evolutionary Algorithm (MOEA). Some applications with MOEAs.

Module- 6: Hybrid Systems **3L**

Introduction to Hybrid Systems, Neuro Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

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	-	2	1
CO2	3	3	2	2	-	-	-	-	1	-	-	1
CO3	3	3	2	2	1	-	-	-	1	-	-	2
CO4	3	3	3	2	2	-	-	-	2	-	-	2

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ANALYTICAL & DIAGNOSTIC EQUIPMENT LAB

COURSECODE: BME 691

CONTACT: 0:0:3

CREDITS: 1.5

Prerequisite: Knowledge in Basic Electronics & Biomedical Instrumentation.

Course Outcomes:

Aftercompletion ofthiscoursethe studentswill beable to:

CO1. Understand the fundamental principles and use of different biomedical analyticaldeviceswith concept ofmeasurementofdifferentsampleconcentration&somephysiologicalparameters.

CO2. Acquire the skills to recognize different biomedical diagnostic devices with their structures, functions and applications.

CO3. Analyse the working principle of different therapeutic devices and how they are applied togivephysiotherapy to patients.

CO4. Investigate & evaluate 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 ratemeter& apnea detection
8. Study on diathermy unit (ultrasound& short-wave)
9. Study of ultrasonic devices -transmitter and detector
10. Study on blood flow velocity measurement-ultrasonic method
11. Innovative experiment

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOSIGNAL PROCESSING LAB
COURSE CODE: BME 692
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Knowledge in Biomedical Signal and Systems

Course Outcome:

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 & 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 & 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.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DATABASE MANAGEMENT SYSTEM LAB
COURSE CODE: BME 695A
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

Course Objective:

To develop conceptual understanding of database management system for solving different industry level problems & to learn its applications.

Course Outcome:

After completion of this course students will be able to

CO1: Design and implement a database schema for a given problem-domain

CO2: Create and maintain tables using PL/SQL Course Outcome

CO3: Populate and query a database

CO4: Prepare reports

List of Experiment:

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)

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i. Inventory Control System.

ii. Material Requirement Processing

iii. Hospital Management System

i. Railway Reservation System

ii. Personal Information System

iii. Web Based User Identification System

vii. Time-table Management System

10. Innovative experiment

Text Book

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition

Reference Book

1. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.
2. 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	2	-	3	3	2	-	-	-	-	-	-	-
CO2	-	-	3	3	2	-	-	-	2	-	-	-
CO3	2	-	3	3	2	-	-	-	-	2	-	-
CO4	-	-	3	3	2	-	-	-	-	-	-	2

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Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MICROPROCESSORS & MICROCONTROLLERS LAB
COURSE CODE: BME 695B
CONTACT: 0:0:3
CREDITS: 1.5
Prerequisite: Knowledge in Digital Electronics

Course Outcome:

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 Experiment:

1. Write a program in 8085 microprocessor to swap the content of two register B and C containing the values 08H and 06H respectively.
2. Write a program in 8085 microprocessor to add two number 09H and 08H and store the result in 9085H location
3. Write a program in 8085 microprocessor 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 microprocessor to multiply 08H with 03H and store the result in 9065H location.
5. Write a program in 8085 microprocessor to divide 07H by 03H and store the quotient in 9075H and reminder in 9076H memory location.
6. Write a program in 8085 microprocessor 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 microprocessor of shifting block of five (5) data from 9055H location to 9080H location.

8. Write a program in 8085 microprocessor 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 microprocessor 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 microcontroller to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.
17. Write a program in 8051 microcontroller 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 microcontroller 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

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: SOFT COMPUTING LAB
COURSE CODE: BME 695C
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Mathematics, set theory and basic computation.

Course Outcome:

After completion of this course student will be able to

CO1: Understand importance of soft computing techniques and tools.

CO2: Remember different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.

CO3: Implement algorithms based on soft computing techniques.

CO4: Apply soft computing techniques to solve engineering or real-life problems.

List of Programs:

1. Overview of Matrix, Matrix Operations, Giving input to Matrix, Displaying elements of Matrix.
2. Performing Operations on Matrix like Addition, Subtraction, and Multiplication.
3. Performing Transpose Operations on Matrix.
4. Plotting of mathematical functions like log(x), sin(x), cos(x) etc
5. Write a Program in MATLAB to check whether a number is even or odd
6. Write a program in MATLAB to find out the sum of "N" natural numbers.
7. Write a Program in MATLAB to generate the fibonacci series upto N, where N is the desired value input by user
8. Write a MATLAB program to solve MATRIX based problems.
9. Write a MATLAB Program to implement LMS Learning rule.
10. Write a MATLAB program to verify McCulloch OR Function.
11. Write a MATLAB program to verify Hebb's Rule.
12. 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)

13. 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]

14. Implementation of Union , Intersection , Complement , XOR Operation and Demorgan's Law
15. 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]
16. Write a MATLAB program to implement Deffuzificationof α-cut method for the fuzzy set F = (0.6/a) + (0.3/b) + (0.7/c) + (1.0/d).
17. Project assigned by instructor to model real world problems.
18. Innovative program

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	2	3	2	2	2	-	-	-	2	-	2	1
CO2	3	2	2	2	-	-	-	-	1	-	-	1
CO3	2	3	2	2	1	-	-	-	1	-	-	2
CO4	3	2	3	2	2	-	-	-	2	-	-	2

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: INTELLECTUAL PROPERTY RIGHT
COURSE CODE: MC 601
CONTACTS: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 0

Prerequisite: None

Course Outcomes:

On successful completion of the learning sessions of the course, the learner will be able to

CO1: Explain fundamental aspects of Intellectual property Rights to students

CO2: To disseminate knowledge on patents, patent regime in India and abroad and registration aspects

CO3: To disseminate knowledge on copyrights and its related rights and registration aspects

CO4: To disseminate knowledge on trademarks and registration aspects

CO5: To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects

CO6: To aware about current trends in IPR and Govt. steps in fostering IPR

Course Content

Module- 1: Overview of the IPR **4L**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - International organizations. agencies and treaties,

Module 2: Patents **4L**

Trips Definition, kind of inventions protected by patent-Patentable and Non patentable inventions. Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Le8al requirements for patents — Granting of patent - Rights of a patent-exclusive right. Patent application process: Searching a patent- Drawing of a patent- Filing of a patent- Types of patent applications- Parent document: specification and Claims.

Registration Procedure, Rights and Duties of Patentee, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.

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Module 3: Trademarks **4L**

Trademarks-Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - trademarkregistrationprocesses.

Module- 4: Copyrights **4L**

Right and protection covered by copyright- Law of copy rights: Fundamental of copyright law. originality **of material,** rights of reproduction, rights to perform the worth publicly, copy right ownership issues, obtaining copy right registration, notice of copy right. International copyright law. Infringement of Copyright under Copyright Act

The Role arid Liabilities of lPRs in India – Cyber law issues: Criminal law. data safety, online privacy. Health privacy, Freedom of expression and human rights, net neutrality, national security.

Module- 5: Geographical Indication of Goods **4L**

Types, why and how GI need protection and GI laws. Indian GI act.

Industrial Designs: protection. Kind of protection provided by industrial designs. Integrated Circuits

Module 6: India`s New National IP Policy- 2016 **4L**

Govt. of India step towards promoting IPR – Govt. Schemes IPR – Career Opportunities in IP - IPR in current scenario with case studies.

Text Books:

1. Fundamentals of lP for Engineers: K.Bansl & P.Bansal

2. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

3. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Reference Books:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	2	3	-	-	2	-	2	3	3
CO2	3	1	-	1	-	-	1	-	1	-	3	3
CO3	3	-	1	2	3	-	-	2	-	2	3	3
CO4	3	1	-	1	-	-	1	-	1	-	3	3
CO5	3	-	2	-	2	3	-	-	-	2	3	3
CO6	3	2	-	1	-	-	-	2	2	-	3	3

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Fourth Year Seventh Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours /Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PC	BME 701	Therapeutic Equipment	3	0	0	3	3
2	PE	BME 702A BME 702B BME 702C	Medical Image Processing Medical Robotics & Automation Neural Network & Genetic Algorithm	3	0	0	3	3
3	PE	BME 703A BME 703B BME 703C	Hospital Engineering & Management Bio-MEMs & Bio-Microfluidics Drug Delivery System	3	0	0	3	3
4	OE	BME 704A BME 704B BME 704C	IOT and Telehealth Technology Deep Learning & Machine Learning in Health Care Artificial Intelligence in Clinical Science	3	0	0	3	3
B. PRACTICAL								
5	PC	BME 791	Therapeutic Equipment Lab	0	0	0	3	1.5
6	PE	BME 792A BME 792B BME 792C	Medical Image Processing Lab Medical Robotic & Automation Lab Neural Network & Genetic Algorithm Lab	0	0	3	3	1.5
7	PROJECT	PR 791	Major Project-I	0	0	0	4	2
8	PROJECT	PR 792*	Industrial Training / Internship	0	0	0	0	1
9	PROJECT	PR 793	Skill Development VII: Seminar & Group Discussion	1	0	0	1	0.5
C. MANDATORY ACTIVITIES / COURSES								
10	MC	MC 781	Entrepreneurship & Innovation Skill	0	0	3	3	3 Units
TOTAL CREDIT WITHOUT MOOCS COURSES								**18.5**
D.MOOCS COURSES**								
11	MOOCS COURSES	HM701	MOOCS COURSE-V	3	1	0	4	4
TOTAL CREDIT WITH MOOCS COURSES								**22.5**

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: THERAPEUTIC EQUIPMENTS
COURSE CODE: BME 701
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 Outcome:

After completion of this course students will be able to

CO1: Identify suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc.

CO2: Understand and explain the working principle of different types of therapeutic devices like pacemakers, defibrillators, ventilators, anaesthesia machine and surgical devices like electrosurgery unit.

CO3: Demonstrate 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 & 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 & 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 & 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 & extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO2, argon, He -Ne, Nd – YAG & 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 & J.M. Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
3. J. Webster, “Bioinstrumentation”, Wiley & Sons.

Reference Books:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg., Boston.
2. Cromwell, Weibell & Pfeiffer, “Biomedical Instrumentation & Measurement”, Prentice Hall, India
3. Harry Bronzino E, “Handbook of Biomedical Engineering and Measurements”, Reston, Virginia.
4. Jacobson & Websler, “Medicine & Clinical Engg.

CO – PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEDICAL IMAGE PROCESSING
COURSE CODE: BME 702A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Digital Signal Processing

Course Outcomes:

After completion of the course the students will be able to

CO1: Understand the significance & different application of medical image processing.

CO2: Apply knowledge of Mathematics and Signal Processing to solve Medical Image Processing related problems& achieve better results.

CO3: Analyze performance of different image processing technique in both spatial and frequency domain

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 & 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 inimage processing, some basic morphological algorithms.

Medical Image Security: **3L**

Water marking of medical images, Different Types of Watermarking, Introduction to Steganography & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO–PO Mapping

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEDICAL ROBOTICS & AUTOMATION
COURSE CODE: BME 702B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic Knowledge of Electronics, Sensors, Mechanics and Control.

Course outcome:

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 & 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 & 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 & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011.
4. Barbara Webb and Thomas R Consi, "BioRobotics: Methods & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: NEURAL NETWORK & GENETIC ALGORITHM
COURSE CODE: BME 702C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 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 &dynamic 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 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: HOSPITAL ENGINEERING & MANAGEMENT
COURSE CODE: BME 703A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic Knowledge about biomedical instrumentation and various departments of hospital.

Course Outcome:

After completion of the course, students will be able to

CO1: Define and understand about hospital classification, criteria regarding organization, assessment, management, administration and regulation of modern healthcare technology.

CO2: Gain broad knowledge of workflow of different departments of the hospital and their responsibilities.

CO3: Investigate, evaluate and develop better management of information within the organization, connecting medical professional and other healthcare technology managers for technology planning, procurement and operation requirements to provide solutions for common issues.

CO4: Implement efficient and safe technology use, considering the importance and impact of technology on patient care improving clinical effectiveness, maintaining 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.

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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	3	1	3	1	-	1	1	-	-	1	-	1
CO2	3	1	2	1	2	1	2	2	1	2	2	1
CO3	2	2	3	2	2	2	-	-	2	2	-	2
CO4	2	1	2	2	2	2	2	2	-	-	3	2

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOMEMS & BIOMICROFLUIDICS
COURSE CODE: BME 703B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Mathematics, Basics of sensors, Introduction to device Fabrication, Micro-fabrication Techniques, Fluid Mechanics.

Course outcome:

After completion of this course, students will be able to

CO1: Build a foundation in micro-systems engineering including basic biological/ biochemical concepts and techniques emphasizing biomedical devices.

CO2: Understand material properties important for MEMS system performance; analyze dynamics of resonant micromechanical structures.

CO3: Design and Development of models using microfabrication technique and simulate electrostatic and electromagnetic sensors and actuators.

CO4: Design and evaluation of MEMs and microfluidics based analytical platform as per the requirement.

Course Content

Module- 1: **7L**

Introduction to BioMEMS and microfluidics, Introduction to Bio nano technology, 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.

CO – PO Mapping:

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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DRUG DELIVERY SYSTEM
COURSE CODE: BME 703C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Knowledge on Polymers, Nanomaterials, Analytical chemistry

Course Outcome:

After completion of this course, students will be able to:

CO1: Understand and explain 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: Formulate and evaluate 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 & basic concepts, advantages/disadvantages, factors influencing, Physicochemical & 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, Telepharmacy.

Module- 2: Rate Controlled Drug Delivery Systems 6L

Principles & 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 & 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 mucoadhesion, 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 & 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	-	1	1	2	1	2	-	1
CO2	3	2	3	2	-	2	2	2	2	1	1	2
CO3	3	3	3	3	3	2	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	1	2	3

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: IOT & TELEHEALTH TECHNOLOGY
COURSE CODE: BME 704A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisite: NIL

Course outcomes:

On completion of this course, the students shall be able to

CO1: Ascent the basic concepts of IOT in healthcare.

CO2: Relate 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.

Module-1: IOT: An Introduction **12L**

Introduction to Embedded Systems-an overview, features. Networked Embedded Systemtypes and overview, wireless communication standards-zigbee, Bluetooth & Wi-Fi. OSI & 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 & diagnostics, Home healthcare & Personal care & Fitness.

Module-2: IOT Hardware Platform& Sensor Interface **8L**

Introduction to CC3100 Wi-Fi BoosterPack: overview & 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 & server class APIs.

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Module- 4: Embedded Web-Server & 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 & HTML basics Overview of different IOT Cloud Services.

Module- 5: Application Design & 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 & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: DEEP LEARNING & MACHINE LEARNING IN HEALTHCARE

COURSE CODE: BME 704B

CONTACT: 3:0:0

TOTAL CONTACT HOURS: 36

CREDITS: 3

Prerequisite: Basic programming skills, Algorithm design, Probability, Linear Algebra, Optimization, Statistics, Calculus.

Course Outcome:

After completion of this course students will be able to

CO1: Understand the basic concepts in 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 Modeling, 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 Modeling 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	-	-	-	-	-	-

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ARTIFICIAL INTELLIGENCE IN CLINICAL SCIENCE
COURSE CODE: BME 704C
CONTACT: 3:0:0
TOTAL CONTACT HOURS; 36
CREDITS: 3

Prerequisite: A basic knowledge in linear algebra, discrete mathematics, probability and statistics and data structures.

Course Outcome:

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: THERAPEUTIC EQUIPMENT LAB
COURSE CODE: BME 791
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge of Biomedical Instrumentation.

Course Outcome:

After completion of the course the students will be to

CO1: Understand about different types of medical equipment and demonstrate the measuring of basic medical parameters.

CO2: Explain the working principle of versatile medical equipment.

CO3: Demonstrate 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.

Course Content

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

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO – PO Mapping

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

Curriculum & Syllabus for B.Tech
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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEDICAL IMAGE PROCESSING LABORATORY
COURSE CODE: BME 792A
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Digital Signal Processing

Course Outcomes:

After completion of the course the students will be able to

CO1: Understand the significance & 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 Gray scale Images, change the brightness-contrast & show the different planes of the images.
2. Perform the logical operation on images & 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 gray scales medical Image and displays the result.
7. Compress and reconstruct a RGB and Gray 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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO–PO Mapping

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: MEDICAL ROBOTICS & AUTOMATION LAB
COURSE CODE: BME 792B
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisite: Basic knowledge in robot kinematics (direct and inverse), dynamics and control

Course outcome:

After completion of this course the students will be able to:

CO1: Identify and explain the different types of medical robots and their potential applications.

CO2: Acquire the basic concepts in kinematics, dynamics and control relevant to medical robotics.

CO3: Understand the various roles that robotics can play in healthcare.

CO4: Develop the analytical and experimental skills necessary to design and implement the robotic assistance for medical field.

List of Experiments:

1. Open Loop Position Control
2. Closed Loop Position Control using positional and velocity feedback.
3. Use of analog and digital servo system.
4. Use of PID Control.
5. Experiments on Pneumatic Drives and Actuators.
6. Experiments on Hydraulic Drives and Actuators.
7. Uses of Logic Gates.
8. Programming on Arduino Platform.
9. Programming on PLC for simple control operation.
10. Innovative Experiment

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO – PO Mapping:

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

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Under Autonomy

L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: ENTREPRENEURSHIP & INNOVATION SKILL
COURSE CODE: MC 701
CONTACTS: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 0

Prerequisite: None

Course Outcomes:

After the completion of the course, the students will be able to:

CO1: Comprehend the role of bounded rationality, framing, causation and effectuation in entrepreneurial decision making.

CO2: Demonstrate an ability to design a business model canvas.

CO3: Evaluate the various sources of raising finance for startup ventures.

CO4: Explain the fundamentals of developing and presenting business pitching to potential investors.

Course Content

Module 1: Introduction to Entrepreneurship 4L

Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioral; entrepreneurial challenges. Entrepreneurial Opportunities: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Module 2: Entrepreneurial Process and Decision Making 4L

Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, Effectuation and Causation; Advantage and Limitations of Entrepreneurship; Process of Entrepreneurship.

Module 3: Crafting business models and Lean Start-ups 4L

Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Module 4: Organizing Business and Entrepreneurial Finance 4L

Forms of business organizations; organizational structures; Evolution of Organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Module 5: Entrepreneurs as problem solvers 4L

Innovations and Entrepreneurial Ventures – Global and Indian; Role of Technology – E-commerce and social media; Social Entrepreneurship – Concept; Entrepreneurship – The Indian Scenario

Module 6: Project/Case Study: (Any One) 4L

1. Visit of the District Industries Centre and prepare a report of activities and programs undertaken by them

2. Conduct a case study of any entrepreneurial venture in your nearby area.

3. Field Visit: Visit any business firm near your locality; interact with the owner of the business firm and prepare a field report on parameters like: type of business, scale of business, product/service dealing in, target customer, problems faced and measures to solve the faced challenges. 4. Know your State Handicraft and Handlooms as a means of economic activity

Text Books:

1. Bessant, J. (2003) High Involvement Innovation: Building and Sustaining Competitive Advantage Through Continuous Change. Chicester: John Wiley & Sons.
2. Bygrave, W and Zackarakis, A (2013) Entrepreneurship, 3rd Edition, John Wiley and Co. Drucker, P. (1999) Innovation and Entrepreneurship, Butterworth Heinemann, Oxford.
3. Fagerberg, J, Mowery, DC and Nelson, RR (2005) The Oxford Handbook of Innovation, Oxford University Press, NY.
4. Hisrich, R.D., Peters, M.P., and Shepherd, D. (2013) Entrepreneurship, McGraw-Hill Irwin, Boston.
5. Kuratko, D. (2013) Entrepreneurship: Theory, Process, and Practice, 9th Edition, Wiley online library.
6. Moore, Geoffrey, (1999) Crossing the Chasm, Harper & Collins.
7. Porter, ME, Competitive Advantage: Creating and Sustaining Superior Performance, Free Press, New York, NY, 1985.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

CO-PO Mapping:

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

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Fourth Year Eighth Semester

Sl No	Course Code	Paper Code	Theory	Contact Hours /Week				Credit Points
				L	T	P	Total	
A. THEORY								
1	PC	BME 801	Artificial Organ & Rehab Engineering	3	0	0	3	3
2	PE	BME 802A BME 802B BME 802C	Biological Control System Computational Biology Quality Assurance & Regulatory aspects of Medical Equipment	3	0	0	3	3
3	PE	BME 803A BME 803B BME 803 C	Laser and Fiber Optics in Healthcare Radiotherapy and Nuclear Medicine Troubleshooting and Maintenance of Medical Equipment	3	0	0	3	3
B. PRACTICAL								
4	PROJECT	PR 891	Major Project-II	0	0	0	12	6
5	PROJECT	PR 892	Grand Viva	0	0	0	0	1
C. MANDATORY ACTIVITIES / COURSES								
8	MC	MC 881	Essence of Indian Knowledge Tradition	0	0	3	3	3 Units
TOTAL CREDIT								**16**

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COURSE NAME: ARTIFICIAL ORGAN & REHABILITATION ENGINEERING

COURSECODE: BME 801

CONTACT: 3:0:0

TOTAL CONTACT HOURS: 36

CREDIT: 3

Prerequisite: Basic knowledge of Engineering Physiology, Anatomy, Biomaterials & Biomechanics.

Course Objective:

1. To impart knowledge on various types of assist devices.
2. To give a basic idea of the artificial organs that can aid a human to live a normal life.
3. To provide the awareness of how a help can be rendered to a differently-abled person.
4. To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn how to operate.

Course Outcome:

After completion of this course students will be able to

CO1: Identify various types of host tissue response with respect to different biomaterials used for design and development 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: Identify the problem and interpret the abnormality in physiological system and analyse the performance measurement of the corresponding artificial organ.

CO4: Acquire the knowledge and skills for providing 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 & Basic methods of waste removal, Hemodialysis, Equation for artificial kidney & middle molecule hypothesis, Different types of Hemodialyzers (Flat-Plate, Coil Type & Hollow Fiber Type), Analysis of mass transfer in dialyzers (cross current & counter current flow), regeneration of dialysate, Wearable Artficial Kidney Machine.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Module- 3: Artificial Heart-Lung Machine & 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 & application.

Module- 5: Rehabilitation Engineering 10L

Measurement & Assessment of Impairments, Disabilities & Handicaps, Engineering concepts in communication disorders, sensory & motor rehabilitation. Rehabs for locomotion, visual, speech & hearing, Artificial Limb, Prosthetic Heart Valve, Myo-electric Hand & 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	2	-	2	1	-	-	-	-	-	-	-
CO2	3	2	-	1	2	-	-	-	-	-	-	-
CO3	3	2	3	2	2	-	-	-	-	2	-	1
CO4	3	1	3	1	2	-	2	-	-	-	-	2

Curriculum & Syllabus for B.Tech
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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: BIOLOGICAL CONTROL SYSTEM
COURSE CODE: BME 802A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Fundamentals of control system.

Course Outcome:

After completion of the course, students will be able to

CO1: Define and understand the basic concept of Engineering Control System as well as Biological Control System and their related Mathematical approaches.

CO2: Gain in- depth knowledge to explain the different biological process regulations and biological control processes.

CO3: Identify and logically comprehend the resemblance and difference among various Biological Control Systems & Engineering Control Systems.

CO4: Analyse the reasons for deviance from normal physiology, considering uniqueness of biological process regulations and interpret the biological control system to restore homeostasis.

Course Content:

Module- 1: Introduction **14L**

Technological Control System, Mathematical approaches, System stability, Differences & 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	1	-	1	2	-	-	-	-	-	2
CO2	3	2	-	-	-	-	1	-	1	1	1	2
CO3	-	3	2	2	1	2	-	-	3	2	2	2
CO4	-	3	-	3	2	-	2	2	2	1	3	3

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: COMPUTATIONAL BIOLOGY
COURSE CODE: BME 802B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisite: Basic knowledge of Biomolecules, Molecular Biology and Organic Chemistry.

Course Outcome:

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

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

COURSE NAME: QUALITY CONTROL & REGULATORY ASPECTS OF MEDICAL EQUIPMENT

COURSE CODE: BME 802C

CONTACT: 3:0:0

TOTAL CONTACT HOURS: 36

CREDITS: 3

Prerequisites: Biomedical Instrumentation, Analytical & Diagnostic Equipment, Therapeutic Equipment & Implants, Imaging Instruments, Principles of management.

Course Outcome:

After completion of this course students will be able to

CO1: Understand and explain the basics of medical devices and process of development

CO2: Investigate and analyze the various safety measures & regulatory requirements for approval of medical devices

CO3: Conduct clinical evaluation, investigation & 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 & Safety 8L

Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modeling, machine elements, ergonomics and prototyping. Security & Safety of the Hospital-property, staff, patients, Electrical safety. Disposal of biological waste, personal protective equipment.

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L – Lecture; T- Tutorial; P- Practical [1L=1Cr, 1T=1Cr, 1P =0.5 Cr]

Module- 3: Design of Medical Devices & 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

Curriculum & Syllabus for B.Tech
Biomedical Engineering
Under Autonomy

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COURSE NAME: LASER AND FIBER OPTICS IN HEALTHCARE
COURSE CODE: BME 803A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Physics, Principle of LASER and Fiber Optics, Anatomy and physiology.

Course Outcome:

After completion of this course, students will be able to:

CO1: Understand the basics and principles of Laser Operations.

CO2: Explain the construction of different laser system and their surgical application

CO3: Describe the various applications of Laser through various medical equipment.

CO4: Demonstrate 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 & 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 & 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- 4: Optical Fiber bundles and Clinical Applications **10L**

Introduction and construction details of optical fibers, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices-fundamentals & 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 & 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:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2	-	-	2	1	-	2
CO2	3	3	2	2	2	2	1	2	2	1	2	2
CO3	3	3	2	1	2	1	2	2	1	1	2	2
CO4	3	2	2	-	2	1	2	-	1	-	2	1
CO5	3	3	2	2	2	2	2	2	2	2	2	1

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COURSE NAME: RADIOTHERAPY & NUCLEAR MEDICINE
COURSE CODE: BME 803B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3
Prerequisites: Basics of Physics, Advanced Medical Imaging.

Course Outcome:

After completion of this course students will be able to

CO1: Understand and explain the utility of Radiotherapy & Nuclear Medicine in healthcare system.

CO2: Investigate and 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& 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**

Characteristics&behaviorofradioactivetracersinbiologicalprocess-(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 & 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 & Michael
5. Principles and practice of Nuclear Medicine, Bruce Sodee, Paul J. Early & 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 & D L Gilday, Chapman and Hall medicals.
5. Nuclear Medicine Technology & Techniques- Donald R. Bernier, Paul E. Christian & James K. Langan Mosby.

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CO-PO Mapping

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

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COURSE NAME: TROUBLESHOOTING AND MAINTENANCE OF MEDICAL EQUIPMENT

SUBJECTCODE: BME 803C

CONTACT: 3:0:0

TOTAL CONTACT HOURS: 36

CREDITS: 3

Prerequisites: Basics of Biomedical Instrumentation & Different types of Medical Equipment.

Course Outcome:

After completion of this course student will be able to

CO1: Understand and explain the basic design processes of medical device.

CO2: Investigate and analyse the various construction and development protocol of medical devices.

CO3: Apply the concept of safe device applications& 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 & 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.

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Module- 5: **8L**

Maintenance of pc based medical equipment: Introduction to - System configuration and BIOS, Identification& 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 & V)

REFERENCE BOOKS:

1. R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009.
2. John G. Webster, Medical Instrumentation: Application and Design, 3rd edition, John Wiley & 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