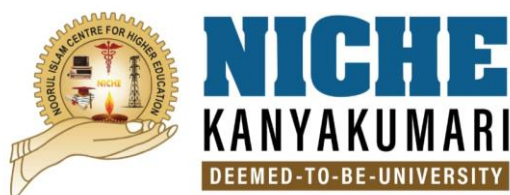


NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF BIOMEDICAL ENGINEERING



**B.E. BIOMEDICAL ENGINEERING
CURRICULUM AND SYLLABI**

REGULATION 2021



NICHE
KANYAKUMARI
DEEMED-TO-BE UNIVERSITY

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

📍 Kumaracoil - 629 180, Kanyakumari District, Tamil Nadu, India

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DEPARTMENT OF BIOMEDICAL ENGINEERING

B.E. BIOMEDICAL ENGINEERING

Curriculum and Syllabi

Regulation: 2021

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Technology

Department of Biomedical Engineering

Vision of the Department

Educate students to understand the human body as an integrated system through quantitative engineering analysis.

Enable the students to design enhanced diagnostic equipment's, therapeutic strategies and devices to create the tool to improve human health in Biomedical Applications.

Mission of the Department

The mission of the Department of Biomedical Engineering at NICHE is to educate men and women who can bridge engineering with life sciences in the service of human health and represent the biomedical profession with distinction. Our department serves as a conduit for better understanding of biology through engineering concepts and for utilizing the complex organization of life systems in developing new technologies.

Description of the programme

Department of Biomedical Engineering offers B.E Biomedical Engineering since 2009, with active clinical/industry partnership in association with our sister institution NIMS Medicity and Research Foundation, Neyyattinkara . Since then, the department has been actively engaged in diversified research and teaching. Its main objective is to provide a knowledge-based, timely, cost effective and high quality service to clinicians in a professional and responsible manner, in order to improve and enhance patient care by supporting all aspects of care related technology. The students of our department make a visit periodically to various departments of our sister medical institutions, and get a deep knowledge about the existing medical devices and instruments. Further, the students carry out in-plant training at prestigious medical industry/institutions, located at various part of India, during their vacation.

Programme Educational Objectives - PEO	
PEO-01	Ability to understand diagnosis and therapy related equipment and to use software tools, mathematics, science and engineering for precise diagnosis
PEO-02	Able to troubleshoot the faulty medical equipment used in healthcare industry.
PEO-03	Apply various bio signal and image processing techniques to solve real time problems in medical field.
PEO-04	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and
PEO-05	To ensure that graduates will recognise the need for sustaining and expanding their technical competence and engage in learning opportunities

Graduate	
GA-1	Innovative Engineering Solutions Develop creative and innovative solutions to complex engineering problems, incorporating the latest technologies and approaches to address current and future challenges.
GA-2	Global Perspective in Engineering Understand and apply engineering solutions in a global context, recognizing the diversity of global issues, standards, and the impact of engineering decisions on different cultures and communities.
GA-3	Sustainable Development and Green Engineering Design and implement engineering solutions that prioritize sustainability, resource efficiency, and environmental protection, contributing to a sustainable future.
GA-4	Social Responsibility and Community Engagement Demonstrate a commitment to social responsibility by engaging with and contributing to local communities, understanding societal needs, and addressing social challenges through
GA-5	Adaptability and Lifelong Learning Exhibit a proactive approach to continuous learning and adaptability, keeping pace with technological advancements and industry changes, and engaging in professional development activities.
GA-6	Entrepreneurship and Innovation Foster an entrepreneurial mindset, identifying opportunities for innovation and creating value through new technologies, products, and processes that meet market needs.
GA-7	Interdisciplinary Collaboration Work effectively in interdisciplinary teams, integrating knowledge from various fields to develop comprehensive solutions to complex engineering problems.
GA-8	Ethical Leadership and Integrity Lead with integrity and ethical principles, ensuring transparency, fairness, and respect in all professional and personal
GA-9	Digital and Data Literacy Utilize advanced digital tools and data analytics techniques to solve engineering problems, optimize processes, and make informed decisions based on data-driven insights.
GA-10	Safety, Health, and Risk Management Prioritize safety, health, and risk management in engineering practices, ensuring the well-being of individuals and communities while minimizing potential risks and hazards.
GA-11	Effective Communication and Negotiation Skills Communicate ideas, solutions, and technical information effectively to a variety of audiences, and engage in negotiation to resolve conflicts and reach consensus.
GA-12	Impact Assessment and Policy Making Assess the impact of engineering projects on society and the environment, and contribute to policy-making processes that promote sustainable and responsible engineering practices.

Programme Outcome – POs

Programme Outcome - POs	
PO-A	Students are familiarized with basic subjects of the Biomedical Engineering
PO-B	Knowledge on the interdisciplinary subjects make them excel in the program
PO-C	Provides the solutions for their experiments through the theoretical knowledge
PO-D	Based on the existing theory and principles, the problems will get new solution in adapting and incorporating the social ethics
PO-E	The knowledge on the Electronics and their applications will help them to do the innovative biomedical projects
PO-F	Group assignments and projects will make them to understand and cooperate with coworkers
PO-G	They can communicate well versed with the team members about the problems and solutions in an effective manner
PO-H	In-plant training enables them to understand their roles and responsibilities as a professional biomedical Engineer in Society
PO-I	To design a biomedical devices to support the needy people
PO-J	Making innovative devices and concepts will make them as professional Engineers

Mapping of Graduate Attributes and Programme Educational Objectives(PEO)

GA PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10	GA-11	GA-12
PEO-01	H	H	H	A	H	H	H	A	H	A	A	N
PEO-02	H	H	A	N	H	H	A	N	A	H	A	A
PEO-03	H	H	H	H	H	H	H	H	H	H	H	H
PEO-04	H	H	H	A	H	A	H	H	A	A	A	H
PEO-05	A	A	H	A	H	H	A	N	H	A	A	N

H- Highly Associated

A- Associated

Not – Not Associated

Mapping of Graduate Attributes and Programme Outcomes (PO)

GAs PEOs	G A- 01	GA- 02	GA- 03	GA- 04	GA- 05	GA- 06	GA- 07	GA- 08	GA- 09	GA- 10	GA- 11	GA- 12
PO-A	H	H	A	A	H	H	H	A	A	A	A	N
PO-B	H	H	H	H	H	H	H	A	A	A	A	N
PO-C	H	H	H	H	H	H	A	A	N	A	A	H
PO-D	H	H	H	H	H	A	A	H	A	A	H	H
PO-E	H	H	H	A	H	H	H	A	A	A	A	H
PO-F	H	H	A	H	H	H	H	H	A	A	H	A
PO-G	H	H	A	H	H	H	H	A	A	A	H	H
PO-H	A	H	A	H	H	H	A	H	A	H	H	H
PO-I	H	A	H	H	H	H	H	H	H	A	H	H
PO-J	H	H	A	A	H	H	A	A	H	A	H	H

H- Highly Associated

A- Associated

Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	H	A	A	N	N
PO-B	H	H	H	A	A
PO-C	A	H	H	A	A
PO-D	A	A	A	H	N
PO-E	H	H	H	A	A
PO-F	A	A	A	A	H
PO-G	A	A	A	H	A
PO-H	A	H	A	H	A
PO-I	H	A	H	A	A
PO-J	H	H	H	A	H

H- Highly Associated

A- Associated

Not – Not Associated

Duration of the program: 4 Years/ 8 Semesters

Total credit: 165

CURRICULUM & SYLLABI**SEMESTER I**

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3101	Technical English	3	1	0	4
2.	MA3101	Engineering Mathematics – I	3	1	0	4
3.	BS3101	Engineering Physics	3	0	0	3
4.	BS3102	Engineering Chemistry	3	0	0	3
5.	CS3101	Fundamentals of Computing and Python Programming	3	0	0	3
PRACTICAL						
6.	CS3171	Fundamentals of Computing and Python Programming Laboratory	0	0	4	2
7.	BS3171	Physics and Chemistry Laboratory	0	0	4	2
TOTAL			15	2	8	21

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3102	Communicative English	3	0	0	3
2.	MA3102	Engineering Mathematics – II	3	1	0	4
3.	BE3101	Basic Electrical and Electronics Engineering	3	0	0	3
4.	BM3101	Biology for Engineers	3	0	0	3
5.	BM3102	Fundamentals of Biomedical Engineering	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICAL						
7.	BM3171	Fundamentals of Biomedical Engineering Laboratory	0	0	2	1
8.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
TOTAL			18	1	6	22

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3202	Numerical Methods and Transforms	3	1	0	4
2.	BM3201	Bio Sensors and Measurements	3	0	0	3
3.	BM3202	Biochemistry	3	0	0	3
4.	BM3203	Digital Electronics for Biomedical	3	0	0	3
5.	BM3204	Human Anatomy and Physiology	3	0	0	3
6.	BM3205	Semiconductor Devices and Circuits	3	0	0	3
PRACTICAL						
7.	BM3271	Bio Sensors and measurements Laboratory	0	0	2	1
8.	BM3272	Biochemistry and Human Physiology Laboratory	0	0	2	1
9.	BM3273	Semiconductor Devices and Digital Electronics Laboratory	0	0	2	1
TOTAL			18	1	6	22

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3206	Random Process	2	1	0	3
2.	BS3201	Environmental Studies	3	0	0	2
3.	BM3206	Bio-Control Systems	3	0	0	3
4.	EE3211	Circuit Theory for Biomedical	3	0	0	3
5.	BM3207	Medical Instrumentation System	3	0	0	3
6.	BM3208	Pathology and Microbiology	3	0	0	3
PRACTICAL						
7.	EE3279	Circuit Theory for Biomedical Laboratory	0	0	2	1
8.	BM3274	Medical Instrumentation System Laboratory	0	0	2	1
9.	BM3275	Pathology and Microbiology Laboratory	0	0	2	1
10.	BM32P1	Summer Internship-I	0	0	0	2
TOTAL			17	1	6	22

SEMESTER V

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	3
2.	BM3209	Linear Integrated Circuits for Biomedical	3	0	0	3
3.	BM3210	Bio Signals and System	3	0	0	3
4.	BM3211	Bio-materials and Implants	3	0	0	3
5.	BM3212	Microprocessor and Microcontroller in Medical Applications	3	0	0	3
6.	BM3213	Communication Engineering for Biomedical	3	0	0	3
PRACTICAL						
7.	BM3276	Linear Integrated Circuits for Biomedical Laboratory	0	0	2	1
8.	BM3277	Microprocessor and Microcontroller in Medical Applications Laboratory	0	0	2	1
TOTAL			18	0	4	20

SEMESTER VI

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	CS32D1	Fundamentals of Artificial Intelligence	3	0	0	3
2.	BM3214	Medical Imaging Equipment	3	0	0	3
3.	BM3215	Diagnostic and Therapeutic Equipment	3	0	0	3
4.	BM3216	Bio-Signal Processing	3	0	0	3
5.	BM32**	Department Elective-I	3	0	0	3
6.	XXXX	Open Elective-II	3	0	0	3
PRACTICAL						
7.	BM3278	Medical Imaging Equipment Laboratory	0	0	3	1
8.	BM3279	Bio-Signal Processing Laboratory	0	0	3	1
9.	BM3280	Diagnostic and Therapeutic Equipment Laboratory	0	0	3	1
10.	BM32P2	Summer Internship II	0	0	0	2
TOTAL			18	0	9	23

SEMESTER VII

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	BM3217	Medical Image Processing	3	0	0	3
2.	BM3218	Virtual Instrumentation for Biomedical	3	0	0	3
3.	BM32**	Department Elective-V	3	0	0	3
4.	MS3202	Principles of Management	2	0	0	2
5.	BM32**	(Department Elective-VI)	3	0	0	3
PRACTICAL						
6.	BM3281	Medical Image Processing Lab	0	0	2	1
7.	BM3282	Virtual Instrumentation for Biomedical Lab	0	0	2	1
8.	BM32P3	Project Work Phase –I	0	0	6	3
TOTAL			14	0	10	19

SEMESTER VIII

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	BM32**	Department Elective-IX	3	0	0	3
2.	OEC	Open Elective-VIII/ Swayam/MOOC Course	3	0	0	3
PRACTICAL						
3	BM3283	Hospital Visit	0	0	2	2
4.	BM32P4	Project WorkPhase –II	0	0	24	8
TOTAL			6	0	26	16

ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32A1	Medical Informatics	3	0	0	3
2	BM32A2	Soft Computing Techniques	3	0	0	3
3	BM32A3	Rapid Prototyping	3	0	0	3
4	BM32A4	Biomechanics	3	0	0	3
5	BM32A5	Neural Engineering	3	0	0	3
6	BM32A6	Medical Robotics	3	0	0	3
7	BM32A7	Drug Delivery Systems and Implantable Devices	3	0	0	3
8	BM32A8	Biomedical Monitoring Equipment's	3	0	0	3
9	BM32A9	Biometric Systems	3	0	0	3

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32B1	Bio-MEMS	3	0	0	3
2	BM32B2	Tissue Engineering and R-DNA technology	3	0	0	3
3	BM32B3	Hospital Engineering and Management	3	0	0	3
4	BM32B4	Advanced Virtual Instrumentation	3	0	0	3
5	BM32B5	Tele Medicine	3	0	0	3
6	BM32B6	Biomedical in Sports	3	0	0	3
7	BM32B7	Artificial Organs	3	0	0	3

OPEN ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32D5	Robotics in Healthcare	3	0	0	3
2	BM32D6	Medical Optics	3	0	0	3
3	BM32D7	Computers in Medicine	3	0	0	3
4	BM32D8	Medical Equipment's Manufacturing Guidelines and Policies	3	0	0	3
5	BM32D9	Intellectual Property Rights	3	0	0	3
6	BM32E1	Rehabilitation Engineering	3	0	0	3
7	BM32E2	Bio fluids and Dynamics	3	0	0	3
8	BM32E3	Hospital System Management	3	0	0	3

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3101	Technical English	3	1	0	4
2.	MA3101	Engineering Mathematics – I	3	1	0	4
3.	BS3101	Engineering Physics	3	0	0	3
4.	BS3102	Engineering Chemistry	3	0	0	3
5.	CS3101	Fundamentals of Computing and Python Programming	3	0	0	3
PRACTICAL						
6.	CS3171	Fundamentals of Computing and Python Programming Laboratory	0	0	4	2
7.	BS3171	Physics and Chemistry Laboratory	0	0	4	2
TOTAL			15	2	8	21

EG3101	TECHNICAL ENGLISH	L	T	P	C
		3	1	0	4

OBJECTIVES

1. To develop the linguistic, communicative and critical thinking competencies of First Year Engineering students
2. To enhance the understanding of the complex grammatical structures of the English language to students
3. To improve the language proficiency of students in English with emphasis on Vocabulary, Grammar, Listening, Speaking, Reading, and Writing skills
4. To introduce the students to the basic phonetics of English and make them grasp the various sounds of the English language to improve their pronunciation

Course Outcome		Cognitive Skill
CO-01	The students will be able to improve their vocabulary relating to Engineering and Technology, and use articles and prepositions effectively in sentences.	R
CO-02	The students will be able to learn grammatical items like tense, voice, compound nouns etc. and thereby enhance their linguistic competence.	U
CO-03	The students will be able to learn definitions of technical terms, relative pronouns etc. which will develop their language competence.	A
CO-04	The students will be able to acquire the essentials of writing skills relating to CV, Resume, Formal and Business Letters.	U
CO-05	The students will be able to learn English phonemes such as Vowels, Diphthongs and Consonants which will be instrumental in improving their pronunciation and speaking skills.	R

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	M	S	M	S	M	L	S	S	M	L
CO-02	M	S	M	S	N	L	M	S	M	S	S	S	N
CO-03	S	S	S	M	S	S	M	S	M	S	M	M	S
CO-04	M	S	S	S	S	S	S	M	S	M	M	S	M
CO-05	S	L	S	M	S	M	M	S	M	M	S	M	S

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I: **9**
Word formation with prefixes and suffixes – Articles – Conjunctions – Prepositions – Expansion of Abbreviations and Acronyms – Writing Checklists – Writing Instructions.

UNIT II: **9**
Tense – Voice – Punctuation – Expansion of Compound Nouns – Writing Recommendations – Paragraph Writing – Types, Structures and Features of a Paragraph – Creating Coherence—Organizing Principles of Paragraphs in Documents.

UNIT III: **9**
Discourse Markers – Gerunds and Present Participles – Relative Pronouns – Conditional Clauses – Definitions of Technical Terms – Transcoding : Bar Chart - Flow Chart - Pie Chart - Tree Diagram - Tabular Column.

UNIT IV: **9**
Concord – Clauses – Phrases – Numerical Adjectives – CV/Resume Writing – Virtual Communication: E-Mail Writing – Essay Writing : Basic Format of an Essay - Types – Examples.

UNIT V: **9**
Basic Phonetics : Phonemes – Vowels, Diphthongs and Consonants – Classification : Pure Vowels/Monophthongs – Vowel Glides /Diphthongs.

TOTAL: L: 45 + T: 15 = 60 HOURS

TEXT BOOK

1. Khaleel Rahuman A., Deepa P., Sheila J., Mathi Vathani J. , *Technical English*, R. K. Publishers, 2023.
2. Shiv Khera, You Can Win, Milan, Delhi, 2004

REFERENCES

1. Nagarajan S., Senthil C. S., Engineering English I & II, Sri Krishna Publications, 2004.
2. Jewelcy Jawahar , Rathna P., English Work Book for First Year B.E./ B.Tech., VRB Publishers, Chennai, 2008.

MA3101	ENGINEERING MATHEMATICS - I	L	T	P	C
		3	1	0	4

OBJECTIVES

The course objective is to develop the required skill of the students in the area of Engineering Mathematics with special emphasis on the characteristic equation of matrices, differential calculus, Beta and Gamma functions and to develop basic knowledge to the students in double and triple integration.

Course Outcome		Cognitive Skill
CO-01	Understand the characteristic equation and find eigen values and eigen vector of a real matrix. Compute the eigen value and eigen vector using properties. Verify Cayley Hamilton theorem and its applications. Apply orthogonal transformation of a symmetric matrix.	U, A
CO-02	Define the definitions and formula for curvature, radius of curvature, circle of curvature. Apply the formula and solve problems using the required formulas also find the evolute of the curves.	U, A
CO-03	Know about the differentiation formulae and apply on partial derivatives, total derivatives and Jacobians. Verify the functions be maximum or minimum and Lagrange's multiplier method. Express the Taylor's expansion for two variables.	U, A
CO-04	Know the Fundamental concepts of improper integrals, Beta and gamma function and their properties. Develop the skill in the relation between Beta and Gamma Functions. Calculate definite integral values using Beta and Gamma Functions.	U, A
CO-05	Evaluate the double and multiple integrals and can apply these concepts to find areas of regions on a plane or in space. Graph Cartesian and polar equations. Convert Cartesian coordinates into polar coordinates.	U, A

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	M	S	M	S	M	L	S	M	M	L
CO-02	M	S	M	S	N	L	M	S	M	S	S	S	M
CO-03	S	S	S	M	S	M	M	S	M	S	M	M	S
CO-04	M	S	S	S	S	S	S	M	S	M	M	S	M
CO-05	S	L	S	M	S	M	M	S	M	M	S	M	M

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I: MATRICES**9**

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of eigen values and eigen vectors(without proof)– Cayley Hamilton theorem (statement only), verification and its applications – Orthogonal and Symmetric matrices and their properties(excluding proof)- Orthogonal transformation of a symmetric matrix to diagonal form.

UNIT II: DIFFERENTIAL CALCULUS**9**

Curvature – Cartesian co-ordinates and parametric form -Centre and radius of curvature, Circle of curvature – Evolutes.

UNIT III: FUNCTIONS OF SEVERAL VARIABLES**9**

Partial derivatives – Total derivatives – Jacobians – Properties – Maxima and minima for functions of two variables–Lagrange Multiplier method- Taylor's expansion.

UNIT IV: IMPROPER INTEGRALS**9**

Evaluation of improper integrals- Beta and Gamma functions – Properties – Relation between Beta and Gamma functions - Evaluation of integrals using Beta and Gamma functions.

UNIT V: MULTIPLE INTEGRALS**9**

Evaluation of double and triple integrals – Area enclosed by plane curves as double integral in cartesian and polar co-ordinates– Change of order of integration- Transformation of Cartesian coordinates into polar coordinates.

TOTAL: L: 45 + T: 15 = 60 HOURS**TEXT BOOKS**

1. Grewal B.S., "Higher Engineering Mathematics"- 40th Edition , Khanna Publishers, Delhi 2007.

REFERENCES

1. M.Immaculate Mary , K.Uma Samundesvari , K.R.Sobha," Engineering Mathematics – I" First Edition ,Anuradha Publications, 2013.
2. Veerarajan T, " Engineering Mathematics (for first year)", Fourth Edition, Tata McGraw- Hill Publishing Company Ltd., New Delhi , 2007.
3. Erwin Kreyszig, " Advanced Engineering Mathematics", Seventh Edition, Wiley India, 2007.
4. P.Kandasamy , K.Thilagavathy , K.Gunavathy" Engineering Mathematics" Vol.1 S.Chand & Company Ltd.2002.
5. B.V. Ramana,"Higher Engineering Mathematics" Second Edition Tata McGraw- Hill, Publishing Company Ltd.,New Delhi, 2006 .

BS3101	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course objective is to provide basic ideas about the principles of physics related to properties of matter, wave optics, heat, quantum concepts and materials. engineering problems.

Course Outcome		Cognitive Skill
CO-01	Students will be able to understand and apply knowledge about the properties of materials.	R,U,A
CO-02	Students will be able to understand the types of oscillations and the wave nature of light in interference, diffraction and polarization phenomenon.	R,U,A,E
CO-03	Students will be able to state and explain the various laws of thermodynamics, understand entropy and its application.	R,U,A,An, ,E
CO-04	Students gain basic knowledge about quantum mechanics and will be able to solve time dependent and time independent Schrodinger equation for simple potentials.	R,U,A,E,S
CO-05	Students will be able to know the different types of crystal structures and also gain basic knowledge about nanomaterials and biomaterials.	R,U,A,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	S	M	S	M	L	S	M	M	L	S
CO-02	S	S	S	M	L	M	S	M	S	S	S	M	S
CO-03	S	S	S	S	M	M	S	M	S	M	M	S	S
CO-04	S	M	S	S	S	S	M	S	M	M	S	M	M
CO-05	S	S	M	M	M	M	S	M	M	S	M	M	M

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I: PROPERTIES OF MATTER**9**

Elasticity – Poisson's ratio – Stress-strain diagram – factors affecting elasticity – bending of beams – cantilever depression – Young's Modulus- theory and experiment of Young's modulus determination (uniform and non-uniform bending) –Shear Modulus – twisting couple – hollow cylinder – torsion pendulum – determination of rigidity modulus - Bulk Modulus - applications of elastic behaviours of materials.

UNIT II: OSCILLATIONS AND WAVE OPTICS**9**

Oscillations - Rectilinear motion - Oscillations or Vibrations - Simple Harmonic Motion - Damped Harmonic motion - Real oscillatory system - Forced or Driven oscillation. Wave optics - Interference of light – Photons - Young's Double Slit Experiment - Huygens's Principle - Diffraction - Diffraction Grating - Polarization.

UNIT III: THERMAL PHYSICS**9**

Transfer of heat energy (conduction, convection and radiation) - thermal expansion of solids and liquids – expansion joints – bimetallic strips-Thermal conductivity- Forbe's and Lee's disc methods (theory and experiment)- thermal insulation in buildings -Laws of thermodynamics- heat exchanger -solar power- applications of solar power (solar water heater, photo voltaic cell).

UNIT IV: QUANTUM PHYSICS**9**

Matter waves- de-Broglie wavelength - Schrodinger's wave equation-time independent and time dependent equations- physical significance of wave function- uncertainty principle and its application- energy and momentum operators-particle in a one dimensional box- scanning electron microscope- transmission electron microscope-scanning tunnelling microscope.

UNIT V:MATERIAL PHYSICS**9**

Single crystalline, polycrystalline and amorphous materials- Single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, miller indices – inter planar distances. Introduction and applications of Metallic glasses, Shape Memory Alloys (SMA), Nanomaterials, Biomaterials.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Engineering Physics I by Bindhu B, Sagi Rani C, Meenadevi V N, Ganapathi Raman R, RK Publishers 2015.
2. Engineering Physics II by Bindhu B, GeethaKumari R, SugirthaSunil N Y, RK Publishers 2016.
3. Engineering Physics by R K Gaur And S L Gupta, [Dhanpat Rai Publications](#) 2011.
4. A Text Book Oscillations, Waves & Acoustics by Dr. M. Gosh, Dr. D. Battacharya, S. Chand, Revised Edition.

REFERENCES

1. Engineering Physics by Rajendran V, McGraw-Hill, New Delhi, 2013
2. Engineering Physics by Arumugam M, Anuradha Publications, 2014.
3. Principles of Physics by Halliday D, Resnick R and Walker J, Wiley 2015.
4. Physics for scientist and Engineers by Serway R A and Jewett J W, Cengage Learning 2010.
5. Engineering Physics by Bhattacharya D K and Poonam T, Oxford University Press 2015.
6. Engineering Physics by Pandey B K and Chaturvedi, Cengage Learning India 2022.

BS3102	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

To make the students conversant with the principles of the following topics:(i) Use of free energy in chemical equilibria(ii) Water chemistry (iii) Periodic properties (iv) Spectroscopic techniques and applications and (v) Organic reactions and synthesis of a drug molecule.

Course Outcome		Cognitive Skill
CO-01	Students will be able to access the quality and utility of suitable water for industrial as well as domestic applications.	U, A
CO-02	To develop awareness and usage of conducting polymers as an engineering material.	U,A
CO-03	To understand the uses of various fuels in economic way..	U
CO-04	To identify the electrolytic cell and electrochemical cells with different types of batteries.	An ,A
CO-05	To get basic knowledge about thermodynamically aspects and its applications to engineering.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	S	S	M	S	S	S	S	S	S	S
CO-02	S	S	S	S	M	M	S	S	S	S	S	S	S
CO-03	S	S	S	S	S	S	S	S	S	S	S	S	S
CO-04	S	S	S	S	S	S	S	S	S	M	S	S	S
CO-05	S	S	S	S	S	M	S	S	S	M	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA

9

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

UNIT II: WATER CHEMISTRY**9**

Water as a universal solvent – hard and soft water – reasons for hardness – disadvantages of hard water in washing and industrial purposes - estimation of hardness by EDTA method, problems; boiler feed water – characteristics- softening methods - external conditioning – demineralization (ion exchange) process, desalination by reverse osmosis method- internal conditioning (phosphate, calgon and carbonate conditioning methods); stages in domestic water treatment – disinfection by chlorination, ozone and UV treatments.

UNIT III: PERIODIC PROPERTIES**9**

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

UNIT IV: SPECTROSCOPIC TECHNIQUES AND APPLICATIONS**9**

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering.

UNIT V: ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULE**9**

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

TOTAL: 45 HOURS**TEXT BOOKS**

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition.

CS3101	FUNDAMENTALS OF COMPUTING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures — lists, tuples, dictionaries.
- To do input/output with files in Python.

Course Outcome		Cognitive Skill
CO-01	To know the basics of algorithmic problem solving	U , A
CO-02	To read and write simple Python programs	A
CO-03	To develop Python programs with conditionals and loops	U , A
CO-04	To define Python functions and call them	U , A
CO-05	To use Python data structures — lists, tuples, dictionaries. To do input/output with files in Python	U , A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	M	S	S	M	S	S	S	S	S	S	S
CO-02	S	S	M	S	M	M	S	S	S	S	S	S	S
CO-03	S	S	M	S	S	S	S	S	S	S	S	S	S
CO-04	S	S	S	S	S	S	S	S	S	M	S	S	S
CO-05	S	S	S	S	S	M	S	S	S	M	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: ALGORITHMIC PROBLEM SOLVING

9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II: DATA, EXPRESSIONS, STATEMENTS**9**

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III: CONTROL FLOW, FUNCTIONS**9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained Conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, GCD, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV: LISTS, TUPLES, DICTIONARIES**9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT V: FILES, MODULES, PACKAGES**9**

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copyfile.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
(<http://greenteapress.com/wp/thinkpython/>)
2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES

1. John V Guttag, —Introduction to Computation and Programming Using Python“, Revised and Revised and expanded Edition, MIT Press, 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, —Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4. Kenneth A. Lambert, —Fundamentals of Python: First Programs, CENGAGE Learning, 2012. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition, 2013.
5. Paul Gries, Jennifer Campbell and Jason Montojo, —Practical Programming: An Introduction to Computer Science using Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

BS3171	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- To teach students, the importance of physics through involvement in experiments and to have knowledge of the world due to constant interplay between observations and hypothesis.
- To develop the interest among the students regarding chemistry and their applications in engineering.

Course Outcome		Cognitive Skill
CO-01	The students will be able to analyse the physical principle involved in various instruments and also relate the principle to new applications.	R,U,A,An,E
CO-02	Various experiments in the areas of optics, properties of matter and ultrasonics will nurture the students in all branches of engineering.	R ,U,A, An,E
CO-03	learn and apply basic techniques used in chemistry laboratory for small/large scale water analyses/purification	R,U,A,An,E
CO-04	be able estimate the ions/metal ions present in domestic/industry waste water.	R,U,A,An,E
CO-05	utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification and spectroscopy.	R,U,A,An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	S	S	S	S	S	S	S	S	S	S
CO-02	S	S	S	M	S	S	S	S	S	S	S	S	S
CO-03	S	S	S	S	S	S	S	S	S	S	S	S	S
CO-04	S	M	S	S	S	M	S	S	S	M	S	S	S
CO-05	S	S	M	M	S	S	M	S	S	S	M	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

List of experiments: Physics Laboratory (Any Five Experiments)

1. Determination of velocity of ultrasonic waves and compressibility of the given liquid by Ultrasonic interferometer.(Real and Virtual Lab)
2. Determination of rigidity modulus by Torsional pendulum. (Real and Virtual Lab)
3. Determination of coefficient of viscosity by Poiseulli's method.
4. Determination of Youngs modulus by non-uniform bending method.(Real and Virtual Lab)
5. Determination of LASER parameters using LASER diode. (Real and Virtual Lab)
6. Determination of band gap of the semi-conductor.(Real and Virtual Lab)
7. Determination of wavelength of mercury spectrum by diffraction grating.(Real and virtual lab)
8. Determination of wavelength of light by Newton's rings.(Real and Virtual Lab)
9. Determination of angle of the prism using spectrometer. (Real and Virtual Lab)

List of Experiments : Chemistry Lab (Any FIVE experiments)

1. Determination of conductance of solutions
2. Potentiometry - determination of redox potentials and emfs
3. Synthesis of drug
4. Determination of Chloride content
5. Determination of hardness of water sample
6. Determination of Alkalinity of water sample
7. Virtual lab experiments

CS3171	FUNDAMENTALS OF COMPUTING AND PROGRAMMING LAB	L	T	P	C
		0	0	4	2

OBJECTIVES

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python

Course Outcome		Cognitive Skill
CO-01	To write, test, and debug simple Python	U&A
CO-02	To implement Python programs with conditionals and loops.	U&A
CO-03	Use functions for structuring Python programs.	U&A
CO-04	Represent compound data using Python lists, tuples, dictionaries.	U&A
CO-05	Read and write data from/to files in Python	U&A

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	M	S	S	M	S	S	S	S	S	S	S
CO-02	S	S	M	S	M	M	S	S	S	S	S	S	S
CO-03	S	S	M	S	S	S	S	S	S	S	S	S	S
CO-04	S	S	S	S	S	S	S	S	S	M	S	S	S
CO-05	S	S	S	S	S	M	S	S	S	M	S	S	S

S-Strong, M-Medium, L-Low, N-Not relevant

List of Programs:

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

TOTAL: 45 HOURS

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3102	Communicative English	3	0	0	3
2.	MA3102	Engineering Mathematics – II	3	1	0	4
3.	BE3101	Basic Electrical and Electronics Engineering	3	0	0	3
4.	BM3101	Biology for Engineers	3	0	0	3
5.	BM3102	Fundamentals of Biomedical Engineering	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICAL						
7.	BM3171	Fundamentals of Biomedical Engineering Laboratory	0	0	2	1
8.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
TOTAL			18	1	6	22

SEMESTER – II

EG3102	COMMUNICATIVE ENGLISH	L	T	P	C
		3	0	0	3

OBJECTIVES

- To widen and expand students' knowledge of English vocabulary
- To develop skills of students in the areas of vocabulary, grammar, listening, speaking, reading, and writing
- To develop the knowledge, skills and strategies the student must possess to become proficient readers
- To make the students learn the importance and purpose of communication skills and overcome the communication barriers by gaining confidence
- To make the students understand how to apply technical information and knowledge in practical documents

Course Outcome		Cognitive Skill
CO-01	The students will be able to understand the basic vocabulary items, sentence structures and error detection and correction which, in turn, will expand their knowledge of the English language.	R
CO-02	The students will be able to grasp the LSRW Skills and gain exposure to absorb Comprehension and Note-making.	U
CO-03	The students will get real time practice in speaking through Oral Presentation, Small Talk, Role Play, Debate, Group Discussion etc.	A
CO-04	The students will be able to improve their writing skills through exposure to Report Writing and Letter Writing.	U
CO-05	The students will be able to learn the Theory of Communication, the Importance of Communication, and be introduced to the various facets of Verbal and Nonverbal Communication.	R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	M	S	S	S	S	S	M	M	M
CO-02	S	S	M	S	S	S	S	S	S	M	M	S	S
CO-03	M	S	S	S	M	S	S	M	S	S	S	M	S
CO-04	S	S	S	S	S	S	S	S	S	S	M	M	S
CO-05	S	S	S	S	S	S	S	S	M	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: VOCABULARY AND GRAMMAR**9**

Parts of Speech – Sentence Structures – Technical Vocabulary – Synonyms – Antonyms – Homonyms – Homophones – Misspelled Words – One word Substitutes – Odd Words Out – Changing words from one form to another – Common Errors in English – Correction of Errors in Sentences.

UNIT II: LISTENING AND READING**9**

Reading Comprehension – Skimming – Scanning – Predicting the Content – Comprehension Questions – Inductive Reading – Close Reading – Note Making – Précis Writing.

UNIT III: SPEAKING**9**

Introducing Oneself – Exchanging Personal Information – Small Talk: Family, Friends, Studies, Profession – Speaking: Greeting, Taking Leave – Product Description – Completing information – Gap Exercises – Presentation / Public Speaking Skills – Group Discussion – Debate – Role Play.

UNIT IV: TECHNICAL WRITING**9**

Report Writing – Characteristics of a Report – Categories of Reports – Letter Writing (Formal Letters) : Job Application Letter with Resume – Letter Seeking Permission – Letter of Invitation – Letter Declining an Invitation – Letter of Complaint – Letter of Requisition.

UNIT V: TECHNICAL COMMUNICATION**9**

The Theory of Communication – Definition and Scope – Nature, Importance and Types – Different Communication Models – Barriers to Communication – Effective Communication (Verbal / Non-verbal).

TOTAL: 45 HOURS**TEXT BOOKS**

1. CanField Jack, Chicken Soup for the Soul, Westland, Chennai, 2013
2. Communication Skills. Oxford University Press.
3. Wood, F. T. (2007). Remedial English Grammar. Macmillan.

REFERENCE BOOKS

1. Zinsser, William. (2001). On Writing Well. Harper Resource Book.
2. The Four Skills for Communication – Josh Sreedharan – Foundation Books
3. Communicative English – E. Sureshkumar and P. Sreehari – Orient Blackswan

MA3102	ENGINEERING MATHEMATICS – II	L	T	P	C
		3	1	0	4

OBJECTIVES

- To develop basic knowledge to the students in differential equations and vector calculus.
- The subject is further broadened to the functions of complex variables and complex integration.
- A thorough knowledge about Laplace transforms is also covered to aid the students solve the differential equations.

Course Outcome		Cognitive Skill
CO-01	The Students will be able to solve ordinary differential equations	An , E , S
CO-02	The Students will be able to solve complex variables	E
CO-03	The Students will be able to synthesize complex integration	S
CO-04	The Students will be able to solve Vector Calculus	E , S
CO-05	The Students will be able to Synthesize Laplace transforms	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	M	S	S	N	M	M	S	S	M	M	M
CO-02	S	M	L	N	L	M	S	L	L	S	M	M	S
CO-03	S	L	S	S	L	L	S	S	M	M	S	S	M
CO-04	S	L	M	S	N	L	S	S	M	S	S	M	S
CO-05	S	L	M	M	M	L	N	S	M	M	M	S	N

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I : ORDINARY DIFFERENTIAL EQUATIONS**9**

Linear differential equations of second order with constant and variable coefficients- Cauchy's and Legendre's linear equations – Method of variation of parameters.

UNIT II: COMPLEX VARIABLES**9**

Functions of a complex variable – Analytic function – Necessary conditions- Cauchy- Riemann equations in cartesian and polar co-ordinates - Sufficient conditions(excluding proof) –Properties of analytic function – Harmonic and its conjugate – Construction of analytic function by Milne Thomson method – Conformal mappings $w = z + c$, cz , $1/z$ and Bilinear transformation.

UNIT III: COMPLEX INTEGRATION**9**

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula –Laurent's expansion – Singular points – Residues – Cauchy's Residue theorem – Evaluation of real definite

integral using contour integration(excluding poles on the real axis) - $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and

$$\int_{-\infty}^{\infty} \frac{f(x)}{g(x)} dx$$

UNIT IV: VECTOR CALCULUS**9**

Gradient, Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT V: LAPLACE TRANSFORMS**9**

Laplace transform –Existence condition– Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Transform of Periodic functions. Inverse Laplace transform – Convolution, Initial and Final value theorems (statement only) – Solutions of linear ordinary differential equation of second order with constant coefficients using Laplace transform techniques.

TOTAL L: 45 + T: 15 = 60 HOURS

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics"- 40th Edition , Khanna Publishers, Delhi 2007.

REFERENCES

2. M.Immaculate Mary , K.Uma Samundesvari, Engineering Mathematics – II" First Edition, Anuradha Publications, ,2013.
3. Erwin Kreyszig, " Advanced engineering Mathematics", Seventh Edition, Wiley India, 2007.
4. Veerarajan T, " Engineering Mathematics (for first year)", Tata McGraw- Hill Publishing Company Ltd.,New Delhi,2007.
5. P.Kandasamy , K.Thilagavathy , K.Gunavathy" Engineering Mathematics" S.Chand & Company Ltd.2002.
6. B.V. Ramana,"Higher Engineering Mathematics" Second Edition Tata McGraw- Hill, Publishing Company Ltd.,New Delhi, 2006.

BE3101	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the basic solutions of AC and DC circuits.
- To study the basic principle and operation of AC and DC machines.
- To study the fundamental operations of measuring instruments.
- To study the layout of power system
- To understand the fundamental operation and characteristics of Electron devices
- To understand the implementation of Boolean expression using logic gates.
- To become familiar with basic concepts of Communication system.

Course Outcome		Cognitive Skill
CO-01	Know the basic solutions of AC and DC circuits.	U, R
CO-02	Understand electrical measurements, machines and power system	U, R
CO-03	Know the fundamental operation and characteristics of Electron devices	U, E,S
CO-04	Implement Boolean expression using logic gates.	U, E,S
CO-05	Understand basic concepts of Communication system.	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	S	M	S	S	S	S	L	S	S
CO-02	M	M	S	S	S	M	S	S	S	S	M	S	S
CO-03	S	S	S	S	S	S	S	M	S	S	M	S	S
CO-04	M	S	S	S	S	S	S	S	S	S	M	S	M
CO-05	S	S	S	N	S	S	S	S	S	S	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: ELECTRICAL CIRCUITS

9

Ohms Law, Kirchhoff's laws, Mesh and Nodal Analysis for DC Circuits.

Introduction to AC Circuits, Faraday's Law of Electromagnetic Induction, Lenz law, Inductor, Capacitor, Power factor, Waveforms and RMS value, Average Value, Peak factor and Form factor, Single phase circuits- Series and Parallel, Three phase balanced circuits. Fundamentals of wiring and earthing.

UNIT II: ELECTRICAL MEASUREMENTS, MACHINES AND POWER SYSTEM

9

Operating principles of Moving coil and Moving iron instruments (Ammeter and voltmeter), Dynamometer type watt meter and Energy meter, Errors in Measurements.
Construction, Principle of operation and Applications of DC Generators, DC Motors, Single phase transformers. Structure of power system.

UNIT III: SEMICONDUCTOR DEVICES

9

Introduction to Semiconductors, PN Junction diode-Zener diode and its characteristics-Half wave and Full wave Rectifiers-Bipolar Junction transistor-CB,CE,CC Configuration and characteristics-JFET and MOSFET construction, operation ,characteristics (CS only) and uses.

UNIT IV: DIGITAL ELECTRONICS

9

Number systems-binary arithmetic--Boolean algebra-laws and theorems-Simplification of Boolean expression- logic gates –Implementation of Boolean expression using logic gates-standard forms of Boolean expression.

UNIT V: COMMUNICATION SYSTEMS

9

Block diagram of basic communication system-need for modulation-Types of modulation-Principles of Amplitude and Frequency modulation – pulse analog and digital modulation-AM and FM transmitter and receiver (Block diagram description only) –Satellite Communication Radar Systems-Data transmission and MODEM.

TOTAL: 45 HOURS

TEXT BOOKS

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical,
2. Electronics and Computer Engineering”, Tata McGraw Hill, Second Edition, (2006).

REFERENCES

1. V.N. Mittle “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 1990.
2. V.K.Mehta “Principles of Power System”, S.Chand & Company Ltd, New Delhi, 2001.
3. R.S.Sedha,”Applied electronics”S.Chand&Co.,2006.

BM3101	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand Biological concepts from an engineering perspective
- To understand the inter-connection between biology and future technologies
- To motivate technology application for biological and life science challenges

Course Outcome		Cognitive Skill
CO-01	Define the cells, its structure and function, and Different types of cells and basis for Classification of living organisms.	U, R
CO-02	Explain the immunological science to know the reactions of our body	U,An, R
CO-03	Discuss the biological science related to the different disciplinary areas.	U, E,S
CO-04	Understand development of artificial systems mimicking human action	U, R
CO-05	Demonstrate the concept of biology and its uses in combination with different technologies for production of medicines and production of transgenic plants and animals.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	L	S	M	M	N	M	M	M	L	N	N	N	N
CO-02	L	S	M	M	N	M	M	M	M	N	N	N	N
CO-03	S	S	S	M	S	M	M	M	M	M	M	M	M
CO-04	S	S	S	M	S	M	M	M	M	M	M	M	M
CO-05	S	S	S	M	S	M	M	M	M	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: CELL BIOLOGY

9

Introduction to the cell biology – The Plant Cell and animal Cell, Cell size and shape - Chemical composition - Classification of cell and its properties; Cell membrane- Nucleus –Mitochondria, Endoplasmic Reticulum – Lysosome and Peroxisome; Microscopy and its types.

UNIT II: IMMUNOLOGICAL SCIENCE

9

Immune system and its types; Functional properties of antibodies; Helper T cells and T cell activation;

UNIT III: IMPLEMENTATION OF BIO-NANO SCIENCE**9**

Nano Biomolecules and its various types; Principles and Application of Biosensor; Basics of Biochips – Bio fertilizer – Bioinformatics – Bio fuel.

UNIT IV: SENSING TECHNIQUES**9**

Understanding of Sense organs working – Sensing mechanisms - Sensor Development issues – Digital Camera – Eye Comparison, electronic nose, electronic tongue, electronic skin.

UNIT V: APPLICATION OF BIOLOGY**9**

Brief introduction to Production of vaccines, Enzymes, antibodies, Cloning in microbes, plants and animals, What is Tissue engineering? And its application, transgenic plants and animals

TOTAL: 45 HOURS**TEXT BOOKS:**

1. Cell and Molecular Biology-P.K.Gupta
2. Cell Biology-Verma and Agarwal
3. ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P.,Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., “Biology for Engineers”, Tata McGraw-Hill, New Delhi, 2012.
4. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: A global approach”, Pearson Education Ltd, 2018.
5. T Johnson, Biology for Engineers, CRC press, 2011 Molecular Biology and Biotechnology 2nd ed. J.M. Walker and E.B. Gingold. Panima Publications. PP 434.

REFERENCE BOOKS

1. AlbertsEt.Al. The molecular biology of the cell, 6/e, Garland Science, 2014
2. De Robertis EDP & EMF De Robertis. 2001. Cell and Molecular biology. Lippincott Williams &Wilkins. Bombay.
3. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012 Principles of Biochemistry. 2nd ed. 1993. A.L. Lehninger, D.L.Nelson.M.Cox. Panama Publications. PP. 1090.
4. Introductory Microbiology. 1995, by Trevor Gross.
5. Molecular Biology by G. Padmanabhan, K. SivaramSastry, C. Subramanyam, 1995, Mac Millan.
6. Genetic Engineering –SandhyaMitra. 10. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers)

BM3102	FUNDAMENTALS OF BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To develop the skill of the students in the areas of medical instrumentation system.
- This will be necessary for their effective studies in bioelectric signals and their medical application.
- This course will also serve as a prerequisite for fundamentals in medical imaging systems.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamentals of Biomedical Engineering. Remember the anatomy and physiology of human body.	U, R
CO-02	Understand the basics of medical instrumentation system and the use of microprocessors and microcontrollers in medicine.	U,An, R
CO-03	Remember and understand the source of various bioelectric signals and their medical application.	U, E,S
CO-04	Understand the basic concepts and fundamentals of modern imaging systems and therapeutic equipment's	U, R
CO-05	Learn about the recent advancements in the field of Biomedical Engineering.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	L	M	S	S	S	L	S	S	S	M
CO-02	S	S	M	S	S	S	M	M	M	S	S	M	S
CO-03	S	M	S	S	S	S	S	S	M	S	M	S	S
CO-04	M	S	S	S	M	S	S	S	S	S	S	S	M
CO-05	S	S	M	M	M	S	S	S	M	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: FUNDAMENTALS OF MEDICAL INSTRUMENTATION**9**

What is Biomedical Engineering? History of Biomedical Engineering, Anatomy and Physiological systems of the body – Cardio Vascular system, Respiratory system, nervous system, Sources of biomedical signals.

UNIT II: BASIC MEDICAL INSTRUMENTATION SYSTEM**9**

Performance Requirement of Medical Instrumentation System, Intelligent Medical Instrumentation System – Use of Microprocessor in medical Instruments, Micro processor, Micro Controller. General Constraints in design of Medical Instrumentation System - Types of Biomedical Instrumentation Systems.

UNIT III: BIOELECTRIC SIGNALS AND ELECTRODES**9**

Origin of Bioelectric Signals, Bioelectric Signals – Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electroretinogram (ERG), Electrooculogram (EOG). Purpose of Electrode paste, Electrodes for ECG, EEG and EMG.

UNIT IV: Modern Imaging Systems and Therapeutic Equipments**9**

Basic concepts and fundamentals of – X-ray – Generation, Production, Detection and Application. Magnetic Resonance Imaging-Magnetic Resonance phenomenon- MRI Instrumentation – principle and working, ultrasonic Imaging Instrumentation- Applications of diagnostic ultrasound. Therapeutic Equipments: Cardiac Pacemaker (External and Internal), Energy requirements to excite heart muscle, Methods of stimulations, Haemodialysis Machine, introduction to Lithotriptors.

UNIT V: RECENT TRENDS IN BIOMEDICAL**9**

Basic concepts and Applications in Biomedical- LASIK (LASER), Infusion pumps, Drug Delivery System(BIOMEMS and Nano Technology), Ocular lens (Biomaterials), Endosseous Implant, Artificial Heart, Prosthetic limp (Rehabilitation Engineering).

TOTAL: 45 HOURS**TEXT BOOKS**

1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2014.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2015.

REFERENCES

1. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2012.
2. Joseph J.carr and John M. Brown, “introduction to Biomedical equipment technology”, John Wiley and sons, New York, 2013.

ME3101	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

OBJECTIVES

- To develop skills for communication of concepts, ideas and design of Engineering Products.
- To expose them to existing national standards related to technical drawings

Course Outcome		Cognitive Skill
CO-01	To know and understand the conventions and the methods of engineering drawing.	U, R
CO-02	Interpret Engineering drawings using fundamental technical mathematics.	U, An, R
CO-03	Construct basic and intermediate geometry	U, E, S
CO-04	To improve their visualization skills so that they can apply these skills in developing new products.	U, R
CO-05	To improve their technical communication skill in the form of communicative drawings and comprehend the theory of projection.	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	L	N	S	S	S	L	S	S	S	M
CO-02	S	S	S	S	S	S	M	S	M	S	S	M	S
CO-03	S	S	S	S	S	S	S	S	M	S	S	S	S
CO-04	M	S	S	S	M	S	S	S	S	S	S	S	M
CO-05	S	S	M	M	M	S	S	S	M	S	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION

9

Concepts and conventions: Use of drafting instruments, BIS conventions and specifications – Size, layout and folding of drawing sheets, Lettering and dimensioning. General principles of orthographic projection, First angle projection – Layout of views. **(Not for examination)**

General Plane Curves

Conic sections including the Rectangular Hyperbola (General method); Cycloid, Epicycloid, Hypocycloid and Involute.

UNIT II: PROJECTION OF POINTS, LINES AND PLANES

9

Projection of points, Projection of straight lines located in the first quadrant. Determination of true lengths and true inclinations. Projection of planes- parallel to any one reference plane, perpendicular to any one reference plane, Inclined to any one reference plane and inclined to both reference planes

UNIT III: PROJECTION OF SOLIDS & SECTION OF SOLIDS**9**

Prisms, pyramids, cylinder and cone, axis perpendicular to any one reference plane. Axis parallel to both the planes. Axis inclined to any one reference plane.

Sectioning of solids- Prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane. Obtaining the true shape of section

UNIT IV: DEVELOPMENT OF SURFACES & ISOMETRIC PROJECTION **9**

Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone, Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, Sphere.

UNIT V: ORTHOGRAPHIC PROJECTION & PERSPECTIVE PROJECTION **9**

Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view. Perspective Projection of Solids (Any one Method).

TOTAL: L: 45+P:15 = 60 HOURS**TEXT BOOKS**

1. Venugopal K and Prabhu Raja V, "Engineering Graphics", New Age International Publishers, 2007.
2. Luzadder W J, "Fundamentals of Engineering Drawing", Prentice Hall Book Co., New York, 1998
3. Bhat, N.D.& M. Panchal , Engineering Drawing, Charotar Publishing House,2008

REFERENCES

1. Kumar M S, "Engineering Graphics", Ninth Edition, DD Publications, Chennai, 2007.
2. Bureau of Indian Standards, "Engineering Drawing Practices for Schools and Colleges SP 46-2003", BIS, New Delhi, 2003.
3. Shah, M.B. & B.C. Rana , Engineering Drawing and Computer Graphics, Pearson Education,2008

BM3171	FUNDAMENTALS OF BIOMEDICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To impart the skill of the students in the working of medical instruments
- This will be necessary for their effective studies in working of different types of sensors, Transducers and probes.
- This course will also serve as a prerequisite for fundamentals in medical imaging systems

Course Outcome		Cognitive Skill
CO-01	To understand different components of blood.	U, R
CO-02	To identify the blood group and clotting.	U,An, R
CO-03	To understand the medical devices applied in measurement of body parameters.	U, E,S
CO-04	To understand the working of different types of sensors, transducers and probes.	U, R
CO-05	Knowledge on temperature sensing devices.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	S	M	M	S	S	S	M	M	S	S	M
CO-02	S	S	M	S	S	M	M	M	M	S	S	M	S
CO-03	S	M	S	S	S	S	S	S	M	S	M	S	S
CO-04	M	S	S	S	M	M	S	S	S	M	S	S	M
CO-05	S	S	M	M	M	S	S	S	M	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Identification Blood Group.
2. Blood clotting time.
3. Study of Modern Electrodes
4. Acquisition of Bio-signals through ECG.
5. Blood Pressure measurement using: Sphygmomanometer
6. Heart Rate Measurement – Pulse oxy meter
7. Drug Delivery System using syringe pump
8. Demonstration of Pacemaker
9. Temperature measurement using Analog and Digital Thermometers.
10. Color vision test - ISHIHARA COLOR BLINDNESS TEST.

TOTAL: 30 HOURS

BE3171	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To make basic electrical connection
- To measure the electrical parameters
- To obtain the characteristics of Electron devices
- To verify the operation of logic gates.

Course Outcome		Cognitive Skill
CO-01	Study of Symbols, Cables and Earthing.	U,An
CO-02	Residential house wiring using switches, fuse, indicator, lamp and energy meter.	U,An
CO-03	Fluorescent lamp wiring.	U,An
CO-04	Stair case wiring / Lamp control from three different places/ Doctor Room control/ Go down control	A,An
CO-05	Measurement of electrical quantities	A,An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	L	L	M	M	M	L	S	S	L	S
CO-02	S	S	M	L	L	M	S	S	L	S	S	L	S
CO-03	S	S	S	L	L	M	M	M	L	S	S	L	S
CO-04	S	S	S	L	L	M	M	S	L	S	S	L	S
CO-05	S	S	M	L	L	M	S	S	L	S	S	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

I. Electrical Engineering Lab

- 1 Study of Symbols, Cables and Earthing.
- 2 Residential house wiring using switches, fuse, indicator, lamp and energy meter.
- 3 Fluorescent lamp wiring.
- 4 Stair case wiring / Lamp control from three different places/ Doctor Room control/ Go down control
- 5 Measurement of electrical quantities – voltage, current, power & computation of power factor in RLC circuit.
- 6 Measurement of energy using single phase energy meter.
- 7 Fan Wiring.

II. Electronics Engineering Lab

1. Study of Electronic components and equipments – Resistor, colour coding, Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Characteristics of PN Junction diode
3. Characteristics of Zener diode
4. Voltage Regulator using Zener diode
5. Measurement of ripple factor of HWR and FWR.
6. Study of logic gates AND, OR, EX-OR and NOT, NAND and NOR.
7. Generation of Clock Signal.
8. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.

TOTAL: 30 HOURS

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3202	Numerical Methods and Transforms	3	1	0	4
2.	BM3201	Bio Sensors and Measurements	3	0	0	3
3.	BM3202	Biochemistry	3	0	0	3
4.	BM3203	Digital Electronics for Biomedical	3	0	0	3
5.	BM3204	Human Anatomy and Physiology	3	0	0	3
6.	BM3205	Semiconductor Devices and Circuits	3	0	0	3
PRACTICAL						
7.	BM3271	Bio Sensors and measurements Laboratory	0	0	2	1
8.	BM3272	Biochemistry and Human Physiology Laboratory	0	0	2	1
9.	BM3273	Semiconductor Devices and Digital Electronics Laboratory	0	0	2	1
TOTAL			18	1	6	22

MA3202	NUMERICAL METHODS AND TRANSFORMS	L	T	P	C
		3	1	0	4

OBJECTIVES

- To develop the skill of the students in the areas of Transform techniques and numerical analysis.
- This will be necessary for their effective studies in a large number of Engineering applications namely communication systems, electro-optics and electromagnetic theory.
- This course will also serve as a prerequisite for post graduate and specialized studies in research.

Course Outcome		Cognitive Skill
CO-01	Compute the solution of nonlinear equations using Newton's Rapson Method, Fixed Point Iteration method. Solve a linear system of equation using direct and iterative method.	U, R
CO-02	Solve the initial value problem of first order ordinary differential equation by using single and Multi -step methods	U, An
CO-03	Derive a Fourier series of a given periodic function by evaluating Fourier coefficient and expand Fourier cosine and Sine series for given function. Also find the Fourier series for a given numerical methods.	R, U, An
CO-04	Know fundamental mathematical properties of a Fourier transform. Calculate the Fourier transform and its inverse transform of function. Also Know to apply Parseval's and convolution theorem.	U, An, E,A
CO-05	Understand the characteristics and properties of Z-transform. Compute Z-transform and inverse transform and apply Z-transform for solving difference equation.	U, R, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	M	M	S	M	M	S	M	S	M	S	M	M	S
CO-02	S	M	M	M	S	S	M	S	S	M	M	S	S
CO-03	M	M	S	M	M	S	M	M	S	S	S	M	M
CO-04	S	S	S	M	S	S	M	S	M	S	M	M	S
CO-05	S	M	S	M	S	S	M	S	S	S	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: LINEAR AND NON LINEAR EQUATIONS**9**

Solution of non-linear equations-Method of false position, Newton Raphson method , Fixed point iteration method – Solution of linear system of Equations-Direct methods: Gauss Elimination and Gauss-Jordan methods – Iterative methods: Gauss Jacobi and Gauss – Seidel methods- Inverse of a matrix by Gauss-Jordan method.

UNIT II: NUMERICAL SOLUTION OF FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS**9**

Solution of first order differential equations -Single step Methods : Taylor's Series, Euler, Modified Euler methods and Fourth order Runge-Kutta method. Multi-step methods : Milne's and Adam's predictor and corrector methods

UNIT III: FOURIER SERIES**9**

Introduction-Fourier series – Dirichlet's conditions – Euler's formulae - General Fourier Series - Even and odd functions - Half range series - Parseval's identity –Harmonic Analysis

UNIT IV: FOURIER TRANSFORMS**9**

Statement and meaning of Fourier integral theorem – Fourier transform — Properties - Inverse Fourier transform – Fourier Sine and Cosine transforms – Inverse sine and cosine transforms – Properties -Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V: Z-TRANSFORMS**9**

Z- transform – Properties -Standard results - Inverse Z-transform - convolution theorem– Evaluation of inverse Z - transform – Application –Second order difference equations

TOTAL: 45+15 = 60 HOURS**TEXT BOOKS**

- 1.Grewal B.S., “Higher Engineering Mathematics” – 40th Edition , Khanna Publishers, Delhi 2007.
- 2.Gerald, C.F, and Wheatley, P.O, “Applied Numerical Analysis”, Sixth Edition, Pearson Education Asia, New Delhi, 2002

REFERENCES

- 1.Erwin Kreyszig, “Advanced Engineering Mathematics”,10th Edition, John Wiley & Sons, Inc., USA, 2011
- 2.Veerarajan T., “Engineering Mathematics (for Semester III), Tata McGraw – Hill Publishing Company Limited, New Delhi .2007
- 3.Narayanan. S, Manicavachagam Pillay T.K.,Viswanathan. S, Ramaniah. G., “Advanced Mathematics for Engineering students”, Volumes II & III, Viswanathan. S(Printers and Publishers) Pvt Ltd. Chennai 2002
- 4.Balagurusamy, E., “Numerical Methods”, Tata McGraw-Hill Pub. Co. Ltd., New Delhi,1999
- 5.Kandasamy, P.Thilakavathy, K and Gunavathy, K. “Numerical Methods”. S.Chand and Co. New Delhi, 2008

BM3201	BIO SENSORS AND MEASUREMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Understand the purpose of measurement, the methods of measurements and errors associated with the measurements.
- To study about the signal conditioning circuits.
- To study about various types of transducers.
- To study photoelectric and piezoelectric sensors.
- To study about the biological sensors.

Course Outcome		Cognitive Skill
CO-01	Understand the purpose of measurement, the methods of measurements and errors associated with the measurements.	U, R
CO-02	Understand various signal conditioning circuits.	U, An
CO-03	Know the principle of transduction, classifications and characteristics of different transducers and study its biomedical applications.	R, U, An
CO-04	Understand the principles and working of various photoelectric and piezoelectric sensors.	U, An, E
CO-05	Remember and understand the concepts, types, working and practical applications of important biosensors.	U, R, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	M	L	M	L	M	L	S	L	L	L
CO-02	M	M	M	M	L	M	L	L	L	S	M	L	L
CO-03	S	S	S	M	L	S	L	L	L	S	M	L	S
CO-04	M	S	S	M	L	S	L	L	M	S	M	L	M
CO-05	S	S	S	N	L	S	L	L	M	S	M	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: SCIENCE OF MEASUREMENT**9**

Measurement System – Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary Standards.

UNIT II: SIGNAL CONDITIONING CIRCUITS AND RECORDING DEVICES**9**

Functions of signal conditioning circuits, Preamplifiers, Concepts of filters, Impedance matching circuits – AC and DC Bridges – Wheat stone bridge, Kelvin, Maxwell, Hay, Schering – isolation amplifier – PMMC, MI and dynamometer type instruments – dc potentiometer – Digital voltmeter – Multi meter – CRO – block diagram – LCD monitor.

UNIT III: DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS**9**

Strain Gauge: Gauge factor, sensing elements, biomedical applications, strain gauge as displacement & pressure transducers – RTD materials & range, Characteristics – thermistor characteristics – biomedical applications of Temperature sensors – Capacitive transducer – Inductive transducer – LVDT – Thermocouple characteristics – Flow transducer.

UNIT IV: PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS**9**

Phototube – scintillation counter – Photo Multiplier Tube (PMT) – photovoltaic – photoconductive cells – photo diodes – phototransistor – spectrophotometric applications of photo electric transducers – Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducers.

UNIT V: BIOLOGICAL SENSORS**9**

Sensors / receptors in the human body – Chemo receptor – Thermo receptors – baroreceptors – sensors for smell, sound, vision – basic idea about Smart sensors.

TOTAL: 45 HOURS**TEXT BOOKS**

1. H. S. Kalsi, “Electronic Instrumentation”, 3rd edition, Author, Publisher, Tata McGraw-Hill Education, 2010.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2013.
3. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.

REFERENCE BOOKS

1. Albert D. Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 2007.
2. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004

BM3202	BIOCHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the biochemical activities taking place at cellular level.
- To study the chemical composition of blood and urine in normal and abnormal conditions.
- To gain Knowledge about the mechanism of actions of enzymes and co-enzymes, clinical importance of enzymes and interpretation of their activities.
- To study the various analyses to be done in the bio fluids and different equipment's used for this purpose.

Course Outcome		Cognitive Skill
CO-01	Students will learn the Biological solvents & its functions and nucleic acid	U, R
CO-02	To learn the structure and functions of carbohydrate, lipids and Protein	U, An
CO-03	Understand the Chemical Nature of Enzymes and Hormones.	R, U
CO-04	To learn the diagnostic tools used in Clinical Laboratory and need of automation	U, An, E
CO-05	Understand bio chemistry of blood and body fluids	U, R

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	S	S	M	S	S	S	M	M	S
CO-02	S	S	M	M	S	M	M	S	S	L	S	M	S
CO-03	S	M	S	M	M	S	M	S	M	S	M	S	S
CO-04	M	M	S	M	S	M	L	S	S	S	M	M	L
CO-05	S	M	S	M	S	S	M	M	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I : INTRODUCTION**9**

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Nucleic acid: Structure of Chromosome, Gene, DNA & RNA.

UNIT II : INTRODUCTION TO BIOMOLECULES**9**

(a) CARBOHYDRATES: Classification, Uses of Carbohydrates. Metabolism of carbohydrate. (EMP pathway, Krebs cycle).

(b) LIPIDS: Classification, Metabolism of lipids (Fatty acid synthesis, beta oxidation), Cholesterol, Bile acids, Transport of lipids. (c) PROTEIN: Classification, of Protein

UNIT III : ENZYMES AND HORMONES**9**

(a) ENZYMES: Chemical Nature of Enzymes, General Properties, Spectrophotometric measurement of enzymes, Isolation techniques, Diagnostic enzymes. Enzyme biotechnology.

(b) HORMONES: Chemical Nature of Hormones, Properties of hormones

UNIT IV: DIAGNOSTIC TOOL**9**

Amino acids, Techniques of Chromatography, Electrophoresis and architecture of protein molecules, Hormonal Assay and their Significance. Ultra centrifugal separation. Use of Isotopes in Biochemistry. Automation in Clinical Laboratory

UNIT V: BIO CHEMISTRY OF BLOOD AND BODY FLUIDS**9**

Liver Function tests, Renal Function Tests, Blood Analysis, Measurement of Electrolytes and Magnesium, Biochemistry of Urine testing

TOTAL: 45 HOURS**TEXT BOOK**

1. Dr. AmbigaShanmugam, 'Fundamentals of Bio Chemistry for Medical Students', Karthic Printers, Madras 1997.
2. U Satyanarayana & U Chakrapani. Biochemistry. Swapna Printing Works. 2008.
3. RAFI MD "Text book of biochemistry for Medical Student" Second Edition, University Press, 2014

REFERENCES

1. Robert K Murray, Daryl K Granner, Peter A Mays, Victor W Rodwell. Harper's Illustrated Biochemistry. Prited in India. 2003.
2. Tietz Fundamentals of Clinical Chemistry Carl A. Burtis, Edward R. Ashwood 5th Edition
3. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
4. 2. Pamela.C.Champe & Richard.A.Harvey, "Lippincott Biochemistry Lippincott's Illustrated Reviews", Raven publishers, 1994.

BM3203	DIGITAL ELECTRONICS FOR BIOMEDICAL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce basic postulates of Boolean algebra and show the correlation between Boolean expressions.
- To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
- To introduce the concept of memories and programmable logic devices.
- To illustrate the concept of asynchronous sequential circuits.

Course Outcome		Cognitive Skill
CO-01	To understand and examine the structure of various number systems and its application in digital design.	U, R
CO-02	To understand the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.	U, R
CO-03	Understanding of the fundamental concepts and techniques used in digital electronics.	U, R
CO-04	The ability to identify and prevent various hazards and timing problems in a digital design.	E,U, An,
CO-05	The ability to understand, analyze and design various combinational circuits.	A, An,

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO - I	PO- J	PO- k	PO -L	PO- M
CO-01	S	S	S	M	L	L	L	N	N	M	L	L	S
CO-02	S	S	S	M	M	L	L	N	N	M	L	L	S
CO-03	S	S	S	S	S	L	L	N	L	M	L	L	S
CO-04	S	S	S	S	S	L	L	N	L	M	L	L	S
CO-05	S	S	S	S	S	L	L	N	L	M	L	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: NUMBER SYSTEMS

9

Introduction to Number Systems – Decimal Number System – Binary Number System – Octal Number System – Hexadecimal Number System – Number Representation in Binary, Finding the Decimal Equivalent – Conversion of Number systems – Binary Codes – Excess-3 Code, Gray Code – Postulates of Boolean Algebra – Theorems of Boolean Algebra – Sum of Products (SOP)–Product of Sums (POS)–Minterm-Maxterm-Canonical forms – Alphanumeric Codes – Seven-segment Display Code – Error Detection and Correction Codes.

UNIT II: LOGIC GATES AND COMBINATIONAL CIRCUITS**9**

Logic Gates – Universal Gates – Tristate Logic Gates – AND-OR-INVERT Gates – Fan-Out of Logic Gates – Buffers and Transceivers –Karnaugh Map Method – Design procedure of Adder–Subtractor – BCD Adder –Carry Propagation–Look –Ahead Carry Generator – Magnitude Comparator – Multiplexer –Encoders – Demultiplexers and Decoders.

UNIT III: SEQUENTIAL CIRCUITS**9**

Flip flops SR, JK, T, D and Master Slave – Level-Triggered and Edge-Triggered Flip-Flops Flip-Flop Timing Parameters– Counters - Asynchronous / Ripple counters–Synchronous counters–Modulo–n counter–Classification of sequential circuits–Moore and Mealy-Design of Synchronous counters: state diagram-State table–State minimization–State assignment-Register–shift registers-Universal shift register–Shift counters–Ring counters.

UNIT IV: MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS**9**

Design of fundamental mode and pulse mode circuits – Races – Hazards: Static – Dynamic – Essential – Hazards elimination. Memory Devices - RAM ROM, PROM, EPROM, EEPROM, EAPROM– PLA and PAL. Digital integrated circuits: Logic levels – propagation delay– power dissipation – fan-out and fan-in – noise margin – logic families and their characteristics–DTL, RTL,TTL, ECL, CMOS, ADC and DAC.

UNIT V: ASYNCHRONOUS SEQUENTIAL CIRCUITS AND VHDL**9**

Asynchronous sequential logic circuits-Transition stability, flow stability-race conditions, hazards & errors in digital circuits; Analysis of asynchronous sequential logic circuits. RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages –.Subprograms – Test bench. Simulation /Tutorial Examples: adders, counters, flip flop, Mux and De-mux.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Digital Electronics: Principles, Devices and Applications Anil K. Maini, 2007
2. James W. Bignel, Digital Electronics, Cengage learning, 5th Edition, 2007.
3. Morris Mano, 'Digital Design with an introduction to the VHDL', Pearson Education, 2013.
4. Comer "Digital Logic & State Machine Design, Oxford, 2012. net .

REFERENCES

- 1: Mandal," Digital Electronics Principles and applications, MC-Graw Hill Edu,2013
- 2: William Keitz," Digital Electronics –A practical Approach with VHDL, Pearson,2013.

BM3204	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To have a clear understanding of Anatomy of every vital organ.
- To give the idea of functioning of cardiac, nervous, digestive and respiratory system.
- To understand special sensing units responsible for hearing and vision.

Course Outcome		Cognitive Skill
CO-01	Students will learn the structure and functions of skeletal and muscular system.	U, An, R
CO-02	To learn the structure and functions of Nervous and cardiovascular system.	U, R, An
CO-03	Understand the structure and functions of respiratory and digestive system.	U, An, R
CO-04	To learn the excretory and reproductive system.	E,U, An, R
CO-05	Understand sensory organs.	U, An, R

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO- A	PO- B	PO- C	PO- D	PO- E	PO- F	PO- G	PO- H	PO- I	PO- J	PO- K	PO- L	PO- M
CO-01	S	M	S	M	S	S	M	S	S	S	M	M	S
CO-02	S	M	S	M	S	S	M	S	S	L	M	M	S
CO-03	S	M	S	M	M	S	M	S	M	S	M	M	S
CO-04	S	M	S	M	S	S	M	S	S	S	M	M	S
CO-05	S	M	S	M	S	S	M	S	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: SKELETAL & MUSCULAR SYSTEMS

9

The Skeletal System: Skeleton, Functions of skeleton, Classification of bones, Study of joints - Structure and function of a Synovial joint, Bones in head, neck, shoulder, elbow, wrist, fingers, vertebral column, pelvic, thigh, knee, ankle, toe.

The Muscular System: Types of Muscles in the body - The characteristics, structure and functions of the Skeletal Muscles, Smooth Muscles and Cardiac Muscles. Muscles in Bones in head, neck, shoulder, elbow, wrist, fingers, vertebral column, pelvic, thigh, knee, ankle, toe.

UNIT II: CARDIAC AND NERVOUS SYSTEM**9**

Structure of Heart, Pericardium, Chambers, Major Blood Vessels, Blood Supply. Cardiac cycle – ECG – Blood Pressure – Feedback Control for Blood Pressure – Nervous control of Heart. Cardiac output – Coronary and Peripheral Circulation – Structure of Nervous System – Functions of Neurons, Synapse, Reflexes and Receptors, Brain, Brainstem, Ventricles and Spinal Cord. Peripheral and Automatic Nervous System and function of Nervous tissue – Reflex action – Velocity of Conduction of Nerve Impulses. Electro Encephalograph – Autonomic Nervous System.

UNIT III: RESPIRATORY AND DIGESTIVE SYSTEM**9**

Respiratory System - Trachea and Lungs. Physiological aspects of respiration. Exchange of gases – Regulation of Respiration. Disturbance of respiration function. Pulmonary function test. Organization of GI system, Digestion and absorption – Movement of GI tract

UNIT IV : EXCRETORY SYSTEM AND REPRODUCTIVE SYSTEM**9**

Structure of Kidney, Nephron – Mechanism of Urine formation – Urine Reflex – Skin and Sweat Gland – Temperature regulation.

Human Reproductive System: Male reproductive system - Female reproductive system.

UNIT V: SPECIAL SENSES**9**

Special senses: Eye - Structure of Eye, Optics of Eye – Retina - Photochemistry of Vision – Accommodation Neurophysiology of Vision – EOG. Ear – Structure of Ear, Physiology of Internal Ear - Mechanism of Hearing – Auditory pathway, Hearing Tests.

TOTAL: 45 HOURS**TEXT BOOK**

1. Ranganathan T.S, “Text Book of Human Anatomy”, Chand & Co., Ltd, Delhi, 2003.
2. SaradaSubramanyam, K.MadhavanKutty and H.D.Singh – Text book of ‘Human Physiology’ – S.Chand& Company, 2010.(Unit I –IV).
- 3.SujitK.Chaudhuri – Concise Medical Physilogy – New Central Book agency, 2016. (Unit V).

REFERENCES

1. Arthur.C.Guyton – Textbook of Medical Physiology – Prism Book (p) Ltd. 2020.
2. Cyril A.Keele Eric Neil and Neil Norman Joels Samson Wrigths’ Applied Physiology – Oxford University Press – 2019.
3. Tobin C.E., “Basic Human Anatomy”, McGraw-Hill Publishing Co., Ltd., Delhi 1997.
- 4.Gibson .J, “Modern Physiology &Analomy for nurses”, Blackwell SC Publishing 1981.

BM3205	SEMICONDUCTOR DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn the basics of semiconductors types, concept of charge carriers and working of basic PN junction devices.
- To gain knowledge on special diodes like Zener diode, LED and their applications.
- To learn the structure, operation, characteristics of BJT and FET.
- To understand the concept of small signal amplifiers, power amplifiers and h-parameters of amplifier circuits.
- To familiarize with positive and negative feedback amplifiers.

Course Outcome		Cognitive Skill
CO-01	Gains knowledge on the basic concepts of semiconductors and the charge carriers.	U, R
CO-02	Understands the operation of special diodes and their applications.	U, R,
CO-03	Learns the structure, operation and characteristics of BJT, JFET and MOSFET.	U, An, R
CO-04	Understands the concept of CE,CB,CC amplifiers, power amplifiers and h-parameters of amplifier circuits .	U, An, R
CO-05	Understands feedback connections in amplifiers.	U, An, R

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	S	S	L	S	M	M	M	S	S	M	M	S
CO-02	S	S	S	L	S	M	M	M	S	S	M	M	S
CO-03	S	S	S	L	L	S	L	L	L	S	M	L	S
CO-04	S	S	S	L	L	S	L	L	M	S	M	L	M
CO-05	S	S	S	L	L	S	L	L	M	S	M	L	M

- S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: SEMICONDUCTOR BASICS

9

Semiconductor types-Intrinsic semiconductor-Mechanism of holes contributing to conductivity-Generation and recombination of carriers-Extrinsic semiconductor types-Majority, minority charge carriers- Conductivity of intrinsic, N-type, P-type semiconductor-Charge densities in N-type and P-type semiconductor- Total current in a semiconductor-Hall effect- PN Junction diode-structure, operation, characteristics, parameters – transition and diffusion capacitance

UNIT II: SPECIAL DIODES AND APPLICATIONS

9

Zener diode –operation, characteristics and parameters-LED-Seven segment display-LCD-Photovoltaic cell- Diode clippers and clippers- Rectifiers- Half wave rectifier, Full wave rectifier, Bridge rectifier- Zener diode voltage regulator.

UNIT III: BJT AND FET

9

Transistor- Types, structure, operation- Transistor configuration- CB,CE,CC- input and output characteristics and parameters- JFET-structure, operation, characteristics and parameters, MOSFET- D-MOSFET, E-MOSFET – characteristics and parameters- UJT - Characteristics- Saw tooth oscillator.

UNIT IV: AMPLIFIERS

9

h parameter representation of a transistor - CE, CC and CB amplifiers – Analysis of single stage transistor amplifier using parameters voltage gain, current gain, input impedance and output impedance-Frequency response - RC coupled amplifier- Classification of Power amplifiers-Class A, B, AB and C - power output, efficiency and cross-over distortion.

UNIT V: FEEDBACK AMPLIFIERS AND OSCILLATORS

9

Negative Feedback connection types - Voltage/current, series/shunt- Negative feedback amplifier- Common emitter amplifier without emitter bypass capacitor, Emitter follower, Collector feedback biased common emitter amplifier, Multistage amplifier with negative feedback- Positive feedback - Condition for oscillation – RC Phase shift, Wein Bridge, Hartley, Colpitts and Crystal oscillators- Printed Circuit Board basics.

TOTAL: 45 HOURS

TEXT BOOK

1. R.S. Sedha, “A Textbook of Applied Electronics”, S.Chand & Company Ltd., 2008.
2. J.Millman, C.C.Halkias, and Satyabratha Jit, “Electronic Devices and Circuits” Tata McGraw Hill, 2nd Ed., 2007.

REFERENCE

1. Robert L. Boylestad Louis Nashesky, “Electronic Devices and Circuit Theory”, Rourson Education Asia, 2013.
2. David A. Bell, “Electronic Devices and Circuits”, Prentice Hall Publications, 2018.
3. P. Ramesh Babu, “Electronic Devices and Circuits”, Scitech Publications Pvt, Ltd., 2008.

BM3271	BIO SENSORS AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

To study the characteristics of sensors, signal conditioning circuits and display devices.

Course Outcome		Cognitive Skill
CO-01	Understand the purpose of measurement, the methods of measurements, and various measuring devices.	U, E
CO-02	Understand the various characteristics of sensors.	U, An
CO-03	Know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications	U, An, E
CO-04	Remember and understand the concepts, types, working and practical applications of important sensors	R,U
CO-05	Empower the student to critically evaluate sensor and transducer options for a particular biomedical application.	U,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	S	M	M	S	M	S	M	S	S	S
CO-02	S	M	S	S	S	S	M	M	S	S	S	S	M
CO-03	S	S	S	S	M	S	S	M	S	S	S	M	S
CO-04	S	S	S	M	S	L	S	L	S	S	M	S	S
CO-05	S	M	M	S	M	N	M	M	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Measurement of resistance, capacitance, etc using multimeters.
2. Measurement of amplitude, time, frequency using CRO.
3. RC low pass filter, High pass filter.
4. Characteristics of strain gauges.
5. Displacement measurement using LVDT.
6. Characteristics of temperature sensors – thermistor and RTD.
7. Characteristics of thermocouple
8. Characteristics of photo diodes, phototransistor
9. Characteristics of Piezoelectric Transducer.
10. Measurement of resistance, capacitance and inductance using bridge circuits.
11. Isolation amplifier.
12. Study of Biological Sensors

TOTAL: 30 HOURS

BM3272	BIO CHEMISTRY AND HUMAN PHYSIOLOGY LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

- To study the characteristics of biomolecules
- Estimation of Bio fluids in human body.

Course Outcome		Cognitive Skill
CO-01	Learn the physiology of humans and study their functions	U, R
CO-02	Understand the structure of human brain	U, R
CO-03	Analyse and evaluate the biochemical components in blood and urine	U, An, E
CO-04	Understand the metabolic pathways and relate the endpoints with pathological conditions	R,U
CO-05	Evaluate the various procedures and identify disease condition using colorimetric arrays	U,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	L	S	S	S	L	N	M	M	N	S
CO-02	L	S	M	L	N	M	L	S	L	M	S	S	S
CO-03	S	S	S	M	M	N	N	S	S	L	S	S	M
CO-04	S	S	L	S	S	S	M	N	L	S	M	S	N
CO-05	M	S	L	S	M	N	S	S	L	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Testing of various parameters of Vision and Errors of Refraction.
2. Ishihara chart for color blindness and Snellen's chart for myopia and hyperopia – by letters reading and ophthalmoscope to view retina.
3. Testing of Hearing using Tuning Fork.
4. Weber's and Rinnee's test for auditory conduction.
5. Measurement of expiratory flow rate
6. Recording of Electrocardiogram
7. Recording of lung volume using Spirometer
8. Recording of Muscle Contraction using frog. (Demonstration).
9. Study of rate of Conduction of Nerve Impulses in frog. (Demonstration).
10. Isolated Frog Heart Perfusion and Effect of ionic Changes in frog. (Demonstration).
11. Estimation of Glucose, Urea & Total Protein.
12. General Test for Proteins.
13. Testing of Normal Urine.
14. Testing of Sugar and Protein in Abnormal Urine.
15. Estimation using Spectrophotometer.

TOTAL: 30 HOURS

BM3273	SEMICONDUCTOR DEVICES AND DIGITALELECTRONICS LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To verify the working of diodes, transistors and their applications.
- To learn the use of diodes in electronic circuits like clippers, clampers and rectifiers.
- To study common emitter, base configuration of BJT and the working of JFET,UJT.
- To design adder, subtractor, MUX/DEMUX, encoder/decoder and to study the working of RS,JK,D,T flip-flops.
- To understand the simulation of digital circuits using VHDL.

Course Outcome - COs	
CO-01	Understands the characteristics of PN junction diode and Zener diode
CO-02	Learns working of diode applications like clippers, clampers and rectifier circuits.
CO-03	Understands the working of BJT using different transistor configuration and also learns the operation of JFET and UJT.
CO-04	Learns to design combinational and sequential circuits with help of truth table.
CO-05	Understands the simulation of digital circuits using VHDL.

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	S	S	L	S	S	S	S	M
CO-02	S	S	S	M	S	S	S	L	S	S	S	S	M
CO-03	S	S	S	M	S	S	S	L	S	S	S	S	M
CO-04	S	S	S	M	S	S	S	L	S	S	S	S	M
CO-05	S	S	S	M	S	S	S	L	S	S	S	S	M

1. Forward and reverse characteristics of PN junction diode
2. Forward and reverse characteristics of zener diode
3. Application of diodes-Clippers and clampers, Half wave rectifier, Full wave rectifier
4. Characteristics of CE,CB configuration of bipolar junction transistor
5. Characteristics of JFET
6. Characteristics of UJT
7. Design of RC Phase shift oscillator
8. Design of adder and subtractor
9. Design of Multiplexer and Demultiplexer using gates
10. Design of Encoder and Decoder
11. Flip flops - SR,JK,D,T
12. Counters(synchronous and Asynchronous) using flip flops.
13. Shift Registers(SISO,SIPO,PISO,PIPO) using flip flops,7495.
14. Simulation of adder and subtractor using VHDL

TOTAL: 30 HOURS

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3206	Random Process	2	1	0	3
2.	BS3201	Environmental Studies	3	0	0	2
3.	BM3206	Bio-Control Systems	3	0	0	3
4.	EE3211	Circuit Theory for Biomedical	3	0	0	3
5.	BM3207	Medical Instrumentation System	3	0	0	3
6.	BM3208	Pathology and Microbiology	3	0	0	3
PRACTICAL						
7.	EE3279	Circuit Theory for Biomedical Laboratory	0	0	2	1
8.	BM3274	Medical Instrumentation System Laboratory	0	0	2	1
9.	BM3275	Pathology and Microbiology Laboratory	0	0	2	1
10.	BM32P1	Summer Internship-I	0	0	0	2
TOTAL			17	1	6	22

MA3206	RANDOM PROCESSES	L	T	P	C
		2	1	0	3

OBJECTIVES

- To have the fundamental knowledge of basic probability concepts, the standard distributions and random variables which can describe real life phenomena.
- To acquire skills in the basic characteristic features of queuing system and in analyzing queuing models.

Course Outcome – Cos		Cognitive Skill
At the end of the course students should be able to		
CO-01	Know the basic concepts of probability and Random Variables. Understand the characteristic of density random variable and continuous random variable. Able to compute mean, variance and generate moment generating functions.	R,A,U,E
CO-02	Understand the different distributions ie Binomial, Poission, Uniform, Exponential, gamma and normal distribution and its properties.	
CO-03	Analyse the characteristic of two dimensional Random Variables, the properties of joint distribution, Marginal and conditional distributions and compute covariance, correlation and regression.	R,U,A, E
CO-04	Understand the characteristics and properties of strictly stationary, wide-sense stationary, Ergodic processes, Markov process, binomial, sine wave process and Gaussian processes.	R,U,A, E
CO-05	Analyse the characteristics and properties of Auto correlation, cross correlation, power spectral density and cross spectral density. Able to find cross correlation and Auto correlation function of input and output.	R,A,U, E

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	M	S	S	S	M	S	M	S	M	S	M	M	M
CO-02	S	M	M	S	S	S	S	S	S	M	M	S	S
CO-03	M	M	S	M	M	S	M	M	S	S	S	M	S
CO-04	S	S	S	M	S	S	M	S	M	S	M	S	S
CO-05	S	M	S	M	S	S	M	S	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: PROBABILITY AND RANDOM VARIABLE

6

Axioms of probability - Conditional probability – Independent Events –Total probability-Bayes's theorem- Random variable - Probability mass functions - Probability density functions - Distribution functions- Properties – Expectation – Moments - Moment generating function and its properties.

UNIT II: STANDARD DISTRIBUTIONS

6

Binomial, Poisson, Uniform, Exponential, Gamma and Normal distributions and their properties (Problems only) –Central Limit Theorem.(without proof)

UNIT III: TWO DIMENSIONAL RANDOM VARIABLES

6

Joint distributions - Marginal and Conditional distributions –Expectation-Independence-Covariance – Correlation and Regression .

UNIT IV: RANDOM PROCESSES

6

Definition and Examples - first order, second order, strictly stationary, wide – sense stationary and Ergodic processes - Markov process - Binomial, Sine wave process and Gaussian processes

UNIT V: CORRELATION AND SPECTRAL DENSITIES

6

Auto Correlation - Cross Correlation - Properties – Power spectral density – Cross spectral density –Properties-Relationship between cross power spectrum and cross correlation function- Linear time invariant system - System transfer function –Linear systems with random inputs – Auto correlation and cross correlation functions of input and output – Fundamental theorem of power spectral density.

TOTAL:30+15 = 45 HOURS**TEXT BOOKS**

- 1.Ross, S., “A First Course in Probability”, Fifth edition, Pearson Education, New Delhi, 2002 (Chapters 2 to 8)
- 2.Peebles Jr. P.Z., “Probability Random Variables and Random Signal Principles”, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2002 (Chapters 6, 7 and 8).

REFERENCES

- 1.Henry Stark and John W. Woods “Probability and Random Processes with Applications to Signal Processing”, Pearson Education, Third edition, Delhi, 2002.
- 2.Veerarajan. T., “Probability, Statistics and Random Processes”, Tata McGraw-Hill Publications, Second Edition, New Delhi, 2002.
- 3.Ochi, M.K. , “Applied Probability and Stochastic Processes”, John Wiley & Sons, New York, 1990.
- 4.Douglas C. Montgomery and George C.Runger, “Applied Statistics and Probability for Engineers”, 3rd Edition , John Wiley & Sons (2004).

BS3201	ENVIRONMENTAL STUDIES	L	T	P	C
		3	0	0	2

OBJECTIVES

- To understand the basic concepts in environmental science
- To gain the knowledge about structure and natural cycles of environment.
- To get an idea about control methods of pollution.
- To know the information about conservation methods of forest and wild life.

Course Outcome		Cognitive Skill
CO-01	Student will be able to demonstrate a general understanding of interdisciplinary nature of environmental uses and able to characterize natural resources.	U, A, An
CO-02	Students will be able to explain the effects of air, water, soil, noise and thermal pollution environment and suggest ways to reduce them.	R, E, A
CO-03	Students will be able to explain the effects of air, water, soil, noise and thermal pollution environment and suggest ways to reduce them.	R, U, A
CO-04	Students will be able to understand the effects of human population and know about the awareness programme.	R, A, E
CO-05	Students apply systems concept and methodologies to analyse and understand interaction between social and environmental process.	R, A, An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	M	S	S	S	M	S	S	M	S
CO-02	M	M	S	M	S	S	S	S	M	S	S	M	M
CO-03	M	M	S	M	S	S	S	S	M	S	S	M	M
CO-04	M	M	S	S	M	S	S	S	M	S	S	M	L
CO-05	M	M	S	S	L	S	M	S	M	S	S	L	M

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I: NATURE OF ENVIRONMENT STUDIES AND NATURAL RESOURCES

9

Environment studies- definition – scope and importance- need for public awareness-Methods to create environmental awareness- Natural resources- Forest resources- energy resources- food resources- water resources – land resources - mineral resources.

UNIT II: ECO SYSTEMS AND BIO-DIVERSITY

9

Concept and component of eco systems- producer, consumer, decomposer- structure and function of eco system- food chain and food web- energy flow model- aquatic eco system forest eco system- desert eco system- pyramid of biomass- ocean eco system- grass land eco system- Bio diversity in India- value of bio diversity- biodiversity threatens- biodiversity protection- In-situ and Ex-situ conservation.

UNIT III: ENVIRONMENTAL POLLUTION

9

Meaning of environmental pollution- air pollution- acid rain – global warming- water pollution- water pollution control- soil pollution- urban waste and soil pollution- marine pollution- noise pollution- thermal pollution- solid and hazardous waste management- waste disposal methods- solid waste and India- natural disaster and disaster management.

UNIT IV: HUMAN POPULATION AND ENVIRONMENT

9

Population growth- distribution of population- factors affecting variation in population theories of population- future of human population- family welfare programme- HIV and AIDS- environment and human health- human rights- value education- women and child welfare.

UNIT V: SOCIAL ISSUES AND THE ENVIRONMENT

9

Unsustainable to sustainable development- sustainable development in India- water conservation, watershed management and water harvesting- environmental ethics- role of engineer in environmental protection.

TOTAL: 45 HOURS

TEXT BOOKS

1. Cunningham & Saigo: 'Environmental science :A global concern' 4th Ed.W.c. Brown Publishers. USA. 1997 2.Chauhan A.S, 'Environmental studies' 2nd revised ed.2004, Jain Brother publishers, New Delhi

REFERENCES

Benny Joseph : 'Environmental Science and Engineering', 2006, Tata McGraw- Hill Publication.
2. Siddique K.A. : Elements of Ecology and Environmental Pollution, 1st Ed. 2002, Kushal Publication, Varanasi. M

BM3206	BIO-CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study system concept and different mathematical techniques applied in analyzing any given system.
- To learn to do the analysis of physiological control system.
- To study the cardio respiratory control system
- To analyze the biological systems.

	Course Outcome - COs	Cognitive Skill
CO-01	Understand system concept and different mathematical techniques applied in analyzing any given system.	U, An, R
CO-02	Learn function and working of physiological control system	U, R, An
CO-03	Analyze the function of physiological control system	U, An, R
CO-04	Analyze the function of cardio respiratory control system	E, U, An, R
CO-05	Understand system concept of biological systems	U, An, R

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-Denies	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	S	M	M	S	S	S	M	S	S	S
CO-02	M	S	S	S	M	S	M	M	M	S	S	S	S
CO-03	S	M	S	S	S	S	S	M	S	M	S	M	M
CO-04	S	S	S	M	S	L	S	L	S	S	M	S	S
CO-05	S	M	M	S	M	N	M	M	S	S	M	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I INTRODUCTION

9

control system, transfer function, mathematical approaches, system stability, introduction to biological control system, Modelling and block diagram, similarities between biological and engineering control system, biological receptors and receptor characteristics.

UNIT II PHYSIOLOGICAL CONTROL SYSTEMS

9

Introduction to physiological control systems, modelling of human movements, parameter estimation, linearizing

UNIT III PHYSIOLOGICAL CONTROL SYSTEMSII**9**

Urine formation and control, Pupil control systems, skeletal muscle servomechanism, and semi-circular canal, Free swinging limbs, Endocrine control system.

UNIT IV CARDIO RESPIRATORY CONTROL SYSTEM**9**

Cardiac rate, blood pressure, respiratory rate, mass balancing of lungs, oxygen uptake by RBC and pulmonary capillaries, oxygen and carbon dioxide transport in blood and tissues.

UNIT V STUDY OF BIOLOGICAL SYSTEMS**9**

Human Thermal system, Neuro muscular system, Control of Digestive system, Oculo motor system.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Sujit K. Chaudhuri – Concise Medical Physiology – New Central Book agency, 2011
2. Modern control engineering. Ogata Katsuhika. 2nd edition, Prentice Hall of India, 2010

REFERENCE BOOKS:

1. Barry R. Dworkin, Learning and Physiological Regulation (Hardcover), University Of Chicago Press, March 1993.
2. E. Carson, E. Salzsieder, Modelling and Control in Biomedical Systems 2000 (including Biological Systems) (IFAC Proceedings Volumes) (Paperback), Pergamon Publishing, January 2001

EE3211	CIRCUIT THEORY FOR BIOMEDICAL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn the Basic Circuit Elements
- To learn the network theorems for DC and AC circuits
- To Verify various theorems from circuit theory
- To understand the three phase circuits
- To study the transient response for dc circuits
- To learn the resonance and coupled circuits

Course Outcome		Cognitive Skill
CO-01	Understand the Basic Circuit Elements	U, An
CO-02	Ability to apply circuit theorems	U,E
CO-03	Understand the three phase circuits	R,U,A
CO-04	Ability to analyze transients	A,U,R,An
CO-05	Know the resonance and coupled circuits	A, R

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	M	S	S	L	S	M	S	M	S
CO-02	M	S	S	M	S	M	L	S	S	S	S	S	S
CO-03	S	S	S	M	S	S	S	L	M	M	S	M	M
CO-04	M	M	M	M	M	M	M	L	S	M	M	M	S
CO-05	S	M	S	M	S	S	S	L	S	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I BASIC CIRCUIT ELEMENTS

9

Basic Circuit Elements-ohm's law-Resistors in series and parallel circuits-Sources of DC circuits-batteries and effect of internal resistance-voltage and current division in series and parallel circuit. Kirchhoff's Laws-Mesh current and Nodal voltage analysis. Source transformation, star-delta conversion.

UNIT II NETWORK THEOREMS FOR DC AND AC CIRCUITS

9

Network Reduction-Thevenin and Norton's theorem-Superposition theorem-Maximum Power Transfer theorem-Reciprocity theorem for DC and AC circuits.

UNIT III THREE PHASE CIRCUITS**9**

AC circuits - Average and RMS value- complex power, R, RL, RC and RLC Circuits-Phasor diagram-power and power factor. Analysis of three phase, 3- wire and 4-wire circuits with star and delta connected balanced loads. Power measurements in three phase circuits.

UNIT IV TRANSIENT RESPONSE FOR DC CIRCUITS**9**

Steady state and transient response-DC response of an RL circuit-RL decay transients-RC transients- RC decaytransients-RLC Transients.

UNIT V RESONANCE AND COUPLED CIRCUITS**9**

Series and parallel resonance-frequency response of series and parallel circuits-Quality factor and Bandwidth-Self and Mutual inductance-Coefficient of coupling-Introduction to tuned circuits.

TOTAL: 45 HOURS**TEXT BOOKS**

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, edition, New Delhi, 2013.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2013.
3. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.

REFERENCES

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999.
2. Jegatheesan, R., "Analysis of Electric Circuits," McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, McGraw- Hill, New Delhi, 2010.
4. M E Van Valkenburg, "Network Analysis",Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
5. Mahadevan, K., Chitra, C., "Electric Circuits Analysis," Prentice-Hall of India Pvt Ltd., New Delhi, 2015.
6. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley & Sons, Inc. 2015.
7. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.

BM3207	MEDICAL INSTRUMENTATION SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study about bio-potential recording and different types of electrodes.
- To study the operational principles of various bio potential recording devices.
- To understand various biochemical measuring instruments and patient monitoring equipment.
- To familiarize with special medical equipment and their working principle.
- To gain knowledge about various electric shock hazards and patient safety.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamentals of biomedical instrumentation about various types of electrodes.	U, R
CO-02	Familiarise with various bio potentials and the method of recording the bio signals.	U, R, An
CO-03	Understand the instrumentation of various biochemical measuring instruments and patient monitoring equipment.	U, R
CO-04	Gain knowledge about special medical equipment and their working principle.	E,U
CO-05	Understand electric shock hazards and the safety precautions.	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	M	S	L	M	L	S	S	M	M	S
CO-02	S	M	S	M	S	L	M	L	S	S	M	M	S
CO-03	S	M	S	M	M	L	M	L	S	S	M	M	S
CO-04	S	M	S	M	S	L	M	L	S	S	M	M	S
CO-05	M	M	M	M	S	L	M	L	L	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: BIOPOTENTIAL ELECTRODES**9**

Origin of bio potential and its propagation – Electrode-electrolyte interface – Electrode-skin interface – Skin contact impedance – motion artifacts – half-cell potential – polarization – non-polarizable electrode – Surface, needle and microelectrodes – Electrodes for ECG, EEG, EMG.

UNIT II: BIO-POTENTIAL RECORDING**9**

Biological amplifiers – ECG – Einthoven's triangle, standard 12 lead system – EEG – 10-20 electrode system, unipolar, bipolar and average mode – EMG– unipolar and bipolar mode – Recording of ERG, EOG, EGG, GSR and PCG.

UNIT III: BIOCHEMICAL MEASUREMENT AND PATIENT MONITORING**9**

Blood gas analyzer(pH, pO₂, pCO₂, pHCO₃) – auto analyzer – Blood cell counters – Blood glucose sensor – Patient monitoring systems – bed side monitors, central monitors – Central consoling controls – Radio Telemetry (single, multi) – Portable and Landline Telemetry unit.

UNIT IV: SPECIAL INSTRUMENTS**9**

Foetal monitoring Instruments – Baby warmer – Baby Ventilator – Endoscopy unit – Principles of measuring blood pressure – body temperature – blood volume and flow in arteries, veins and tissues – cardiac output measurement – Infusion pumps.

UNIT V: ELECTRIC SHOCK HAZARDS AND PATIENT SAFETY**9**

Electric shock Hazards – Effects of electric current on human body - leakage currents – safety codes for Electrical Equipments – Electrical Safety Analyser – Testing of Biomedical Equipments – grounding.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, Third Edition, 2013.

REFERENCES

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2005.
2. Joseph J.carr and John M. Brown, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, Fourth Edition, 2001.

BM3208	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Outcome		Cognitive Skill
CO-01	Describe the normal homeostatic mechanisms and the pathological process in their derangement and the effects on human systems. Discuss the concepts of cell injury and pathological and immunological responses produced thereby in different tissues and organs and the body's capacity for healing. Describe the concept of neoplasia with reference to the etiology, morphological features, diagnosis and prognosis in different tissues and organs of the body.	U, R
CO-02	Describe the concept of hemodynamic disorders, thromboembolic disease and shock and their clinical application.	U, R, An
CO-03	Recognise and interpret the common hematological disorders and the investigations, blood banking as well as cytological procedures.	U, R
CO-04	Understand the microbial types, growth and its structure	U, R
CO-05	Demonstrate basic Knowledge and understanding of the immune system in health and disease.	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	M	M	S	M	M	M	L	M	M	S
CO-02	S	S	S	M	M	S	M	M	M	M	M	M	S
CO-03	S	S	S	M	L	S	M	M	L	L	L	M	S
CO-04	S	S	S	S	L	S	S	S	L	L	L	L	S
CO-05	S	S	S	S	M	S	S	S	L	M	L	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: CELL DEGENERATION, REPAIR AND NEOPLASIA 9

Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours.

UNIT II: FLUID AND HEMODYNAMIC DERANGEMENTS 9

Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock.

Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas.

UNIT III: INFLAMMATION AND WOUND HEALING 9

Definition, Acute Inflammation, Events in Acute Inflammation – Vascular & Cellular Inflammation - Regulation Of Inflammation -Chemical Mediators of Inflammation – Sequelae of Acute Inflammation – Chronic & Granular Inflammation – Wound Healing.

UNIT IV: ORGANISATION OF MICROBES 9

General Structural Organisation of bacterial and viral cell- growth and identification of bacteria, observation of culture.

Viral disease, Chlamydial, Bacterial, Mycoplasma, Fungal, protozoal and helminthic disease.

UNIT V: IMMUNOPATHOLOGY 9

Hypersensitivity disorders, Immune deficiency syndrome.

Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Antigen-Antibody techniques.

TOTAL: 45 HOURS

TEXT BOOKS

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins: Pathologic Basis of diseases. WB Saunders Co. 7th edn-2005.
2. Harsh Mohan: Text book of Pathology. Jaypee publishers. 4th edn. 2000.
3. Microbiology : Text book - 1. Ananthanarayanan R & Panicker CKJ: Textbook of Microbiology. Orient Longmans. 7th edition 2006.

REFERENCE

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone 3rd edn. 2000.
2. Dubey RC and Maheswari DK. A textbook of Microbiology. S Chand 2007.
3. Prescott, Harley, Klein. Microbiology. McGraw Hill 5th ed. 2002.
4. Manual of Microbiology tools and techniques. Kanika Sharma. Ane's student edition. 2007.
5. Dr. TKG. Nair. MD. Text Book of Practical Pathology.

EE3279	CIRCUIT THEORY FOR BIOMEDICAL LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To learn the Orcad simulation of d.c. circuit
- To learn the Orcad simulation of reciprocity theorem and superposition theorem for dc circuits.
- To Verify various theorems from circuit theory
- To Measure the power factor of a given circuit
- To study the Stair case wiring

Course Outcome		Cognitive Skill
CO-01	Understand the Orcad simulation of d.c. circuit	U, An
CO-02	Understand the Orcad simulation of reciprocity theorem and superposition theorem for dc circuits	U,E
CO-03	Verification of various theorems from circuit theory	R,U,A
CO-04	Measure the power factor of a given circuit	A,U,R,An
CO-05	Know to do the Stair case wiring	A, R

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	P O-J	PO-k	PO-L	PO-M
CO-01	S	M	S	S	S	S	S	L	S	M	S	M	S
CO-02	M	M	S	M	S	M	S	S	S	S	S	S	S
CO-03	S	S	S	M	S	S	S	L	M	M	S	M	M
CO-04	S	M	M	M	M	M	S	L	S	M	S	M	S
CO-05	S	M	S	M	S	S	S	L	S	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Orcad simulation of d.c. circuit for determining thevenin's equivalent
2. Orcad simulation of maximum power transfer theorem for dc circuits
3. Orcad simulation of reciprocity theorem for dc circuits
4. Orcad simulation of superposition theorem for dc circuits
5. Verification of thevenin's theorem.
6. Verification of superposition theorem
7. Verification of reciprocity theorem.
8. Verification of maximum power transfer theorem
9. Measurement of power factor
10. Stair case wiring

TOTAL: 30 HOURS

BM3274	MEDICAL INSTRUMENTATION SYSTEM LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To learn the recording of bioelectric signals like ECG, EEG and EMG.
- To learn the measurement of various physiological parameters using patient monitoring system.
- To study the measurement of pH, pO₂ & conductivity.
- To learn the working principle of infusion pumps and endoscopy
- To study the working principle and modes of operation of therapeutic equipment like baby ventilator, baby warmer, etc.

Course Outcome		Cognitive Skill
CO-01	Understand the measurement of various biomedical signals like ECG, EEG, and EMG	U, An
CO-02	Understand the observation of various vital parameters using patient monitoring system	U,E
CO-03	Study the measurement of pH, pO ₂ & conductivity	R,U,A
CO-04	Study the working principle of infusion pumps and endoscopy	U,R,An
CO-05	Study the working principle and modes of operation of therapeutic equipment like baby ventilator, baby warmer, etc.	U, R

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	S	S	S	L	S	M	S	M	S
CO-02	S	M	S	M	S	S	S	L	S	M	S	M	S
CO-03	S	M	S	M	S	S	S	L	S	M	S	M	S
CO-04	S	M	S	M	S	S	S	L	S	M	S	M	S
CO-05	S	M	S	M	S	S	S	L	S	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Recording of ECG signal and Analysis.
2. Recording of EMG and Analysis.
3. Recording of EEG and Analysis.
4. Recording of various physiological parameters using patient monitoring system
5. Study of biotelemetry units.
6. Measurement of pH, pO₂ and conductivity.
7. Study of Infusion pumps.
8. Study of Baby warmer.
9. Study of Baby Ventilator.
10. Study of leakage current and electrical safety measurements
11. Study of Endoscopy.

TOTAL: 30 HOURS

BM3275	PATHOLOGY AND MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To learn the sterilization process of media and equipment .
- To learn the measurement of various hematological parameters
- To study the measurement of immunological techniques.
- To learn the working principle of Microscope and Antigen – antibody
- To study the working principle and modes of staining techniques.

Course Outcome		Cognitive Skill
CO-01	Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.	U, An
CO-02	Principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.	U,R
CO-03	Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist.	R,U,A
CO-04	They also get introduced a variety of modifications in the microscopes for specialized viewing	U, R, An
CO-05	Several separation techniques which may be required to be handled later as microbiologists.	U, R, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	S	M	S	M	N	M	L	L	S
CO-02	S	S	S	S	S	M	S	M	L	M	M	M	S
CO-03	S	S	S	S	S	M	S	M	N	L	M	L	S
CO-04	S	S	S	S	S	M	S	L	L	M	L	L	S
CO-05	S	S	S	S	M	M	S	L	N	L	L	L	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Hemoglobin Estimation.
2. Peripheral Smear Study.
3. Urine Smear Study
4. Blood Grouping & Rh Typing.
5. Tissue Biopsy – Benign and Malignant.
6. Simple Stain test
7. Gram Stain test.
8. AFB Stain test.
9. ELISA
10. Antigen-antibody techniques (Immuno Diffusion Tests)
11. Immunohistochemistry

TOTAL: 30 HOURS

BM32P1	SUMMER INTERNSHIP I	L	T	P	C
		0	0	0	2

OBJECTIVES

- To understand the scope of health care services and health policies.
- To provide hands-on experience at site where biomedical equipment are manufactured or utilized.
- To familiarize the medical device working standards, maintenance procedures.
- To know the need of biomedical engineers in research and development.

Course Outcome		Cognitive Skill
CO-01	Identify the need and significance of Biomedical Engineering and health policies.	U, A
CO-02	Appreciate the need for standard and quality management in hospitals.	An, A
CO-03	Learner will be able to gain some practical experience in servicing the equipment.	U, E
CO-04	Appraise the code of ethics in design and development.	E, An
CO-05	Evaluate device safety and ensure a secure hospital environment.	E, U

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	S	S	M	S	S	M	S	M	M	S
CO-02	S	M	S	S	S	M	S	S	M	S	M	M	S
CO-03	S	M	S	S	S	M	S	S	M	S	M	M	S
CO-04	S	M	S	S	S	M	S	S	M	S	M	M	S
CO-05	S	M	S	S	S	M	S	S	M	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

DESCRIPTION

Students have to undergo two weeks practical training in biomedical equipment manufacturing companies or hospitals in Hospital equipment maintenance, Hospital Administration and Planning. At the end of the training student will submit a report as per the prescribed format to the department.

SEMESTER V

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	3
2.	BM3209	Linear Integrated Circuits for Biomedical	3	0	0	3
3.	BM3210	Bio Signals and System	3	0	0	3
4.	BM3211	Bio-materials and Implants	3	0	0	3
5.	BM3212	Microprocessor and Microcontroller in Medical Applications	3	0	0	3
6.	BM3213	Communication Engineering for Biomedical	3	0	0	3
PRACTICAL						
7.	BM3276	Linear Integrated Circuits for Biomedical Laboratory	0	0	2	1
8.	BM3277	Microprocessor and Microcontroller in Medical Applications Laboratory	0	0	2	1
TOTAL			18	0	4	20

MS3201	PROFESSIONAL AND BUSINESS ETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To recognize legal and ethical issues in business decision-making.
- To Understand and apply ethical rules and constraints.
- To enhance analytical problem-solving skills and ethical decision-making abilities.

Course Outcome		Cognitive Skill
CO-01	Explore the relationship between ethics and business across different cultural traditions.	U, A
CO-02	Explain the connection between ethics, morals, and values in the workplace.	An, A
CO-03	Formulate an ethical philosophy and relate it to current practices.	U, E
CO-04	Assess the ethical implications of business activities and competing demands on businesses.	E, An
CO-05	Critically analyse real-world contexts and conduct research projects on topics related to business ethics.	E, U

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	S	S	S	M	S	S	M	S	M	M	S
CO-02	S	M	S	M	S	M	S	S	M	S	M	S	S
CO-03	S	M	S	S	S	M	S	S	S	S	M	M	S
CO-04	S	M	S	S	S	M	S	S	M	S	M	M	M
CO-05	S	M	S	S	S	M	S	S	M	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: HUMAN VALUES

9

Morals, Values, and Ethics -Integrity and Work Ethic - Service Learning and Civic Virtue - Respect for Others and Living Peacefully - Caring, Sharing, and Honesty - Courage, Valuing Time, and Co- operation - Commitment, Empathy, and Self-Confidence - Character and Spirituality

UNIT II: ENGINEERING ETHICS**9**

Senses of 'Engineering Ethics' and Moral Issues - Types of Inquiry and Moral Dilemmas - Moral Autonomy and Ethical Theories - Models of Professional Roles - Self-Interest, Customs, and Religion

UNIT III: ENGINEERING AS SOCIAL EXPERIMENTATION**9**

Engineering as Experimentation - Engineers as Responsible Experimenters - Codes of Ethics and Legal Perspectives - Case Study: The Challenger Incident

UNIT IV: SAFETY, RESPONSIBILITIES, AND RIGHTS**9**

Safety, Risk, and Risk Assessment - Risk-Benefit Analysis and Risk Reduction - Case Studies: Three Mile Island and Chernobyl - Collegiality, Loyalty, and Respect for Authority - Conflicts of Interest and Occupational Crime - Professional and Employee Rights - Intellectual Property Rights (IPR) and Discrimination

UNIT V: GLOBAL ISSUES**9**

Multinational Corporations and Environmental Ethics - Computer Ethics and Weapons Development - Engineers as Managers, Consultants, and Expert Witnesses - Sample Codes of Ethics from Professional Organizations.

TOTAL: 45 HOURS**TEXTBOOKS**

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering," McGraw-Hill, New York, Latest edition: 4th edition (2022).
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics," Prentice Hall of India, New Delhi, Latest edition: 2nd edition (2021).

REFERENCES

1. Charles D. Fleddermann, "Engineering Ethics," Pearson Education/Prentice Hall, New Jersey, Latest edition: 4th edition (2022).
2. Charles E Harris, Michael S. Protchard, and Michael J Rabins, "Engineering Ethics - Concepts and Cases," Wadsworth Thompson Learning, United States, Latest edition: 2nd edition (2023).
3. John R Boatright, "Ethics and the Conduct of Business," Pearson Education, New Delhi, Latest edition: 8th edition (2021).
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers," Oxford University Press, Oxford, Latest edition: 2nd edition (2022).

BM3209	LINEAR INTEGRATED CIRCUITS FOR BIOMEDICAL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the basics of Operational Amplifiers
- To study the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of analog multipliers and PLL.
- To study the theory of ADC and DAC
- To introduce a few special function integrated circuits.

Course Outcome		Cognitive Skill
CO-01	Learn about the basics of Operational Amplifiers	U, R
CO-02	Learn about the basic concepts of the circuit configuration for design of linear integrated circuits & develop skills to solve engineering problems	U, An, A
CO-03	Develop skills to design simple circuit using op-amp for various application	U, E, S
CO-04	Gain knowledge about various switches and develop or learn about various techniques to develop ADC & DAC	U, R
CO-05	Gain knowledge about various regulators, timers & multi vibrators to solve problems related with it.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	N	N	L	L	L	M	L	N	M	S
CO-02	M	S	L	M	N	L	L	M	M	L	N	M	S
CO-03	S	S	M	N	N	M	L	L	L	L	N	M	M
CO-04	S	L	L	N	N	L	M	M	M	L	N	M	S
CO-05	S	S	L	N	N	M	L	M	L	L	N	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: BASICS OF OPERATIONAL AMPLIFIERS

9

Basic information about OP-AMP- circuit symbol, pin diagram, power supply connections, manufacturers specifications of LICs. Ideal OP-AMP. D.C performance characteristics of OP-AMP -Input bias current, input offset voltage, Input offset current, Thermal drift. A.C performance characteristics of OP-AMP- frequency response and slewrate.

UNIT II: APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Linear and Nonlinear Circuits using operational amplifiers and their analysis, Inverting and Non inverting Amplifiers, Differentiator, Integrator, Voltage to current converter, Instrumentation amplifier, Sine wave Oscillator, Comparator, Multivibrators and Schmitt trigger, Triangular wave generator, Log and Antilog amplifiers, Non-linear function generator.

UNIT III: ANALOG MULTIPLIER AND PLL 9

Analysis of four quadrant (Gilbert cell) and variable trans conductance multipliers, Voltage controlled Oscillator, Closed loop analysis of PLL, AM, PM and FSK modulators and demodulators, Frequency synthesizers, Compander ICs.

UNIT IV: ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTORS

9

Analog switches, High speed sample and hold circuits and sample and hold ICs, Types of D/A converter, Current driven DAC, Switches for DAC, A/D Converter-Flash, Single slope, Dual slope, Successive approximation, Delta Sigma Modulation, Voltage to Time converters.

UNIT V: SPECIAL MACHINES 9

Astable and Monostable Multivibrators using 555 Timer, Voltage regulators-linear and switched mode types, Switched capacitor filter, Frequency to Voltage converters, Tuned amplifiers, Power amplifiers and Isolation Amplifiers, Video amplifiers, Fiber optic ICs and Opto-couplers.

TOTAL: 45 HOURS

TEXT BOOK

1. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', McGraw-Hill, Fourth edition, 2015.
2. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2018.

REFERENCES

1. Gray and Meyer, 'Analysis and Design of Analog Integrated Circuits', Wiley International, Fifth edition, 2009.
2. J.Michael Jacob, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, 1996.
3. Ramakant A. Gayakwad, 'OP-AMP and Linear IC's', Prentice Hall / Pearson Education, Fourth edition 2015.
4. K.R.Botkar, 'Integrated Circuits'. Khanna Publishers, Tenth edition, 2015.

BM3210	BIOSIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Understand the standard signal and its classification in time domain.
- Understand the classification of system and analyze a continuous time system using Fourier and Laplace transform.
- Analyze a discrete time system using z-transform.
- Analyze a discrete time system using DTFT and to understand properties of an LTI system.
- Understand filter structures using block diagram representation of systems.

Course Outcome		Cognitive Skill
CO-01	Understands standard signals and their classification.	U, R
CO-02	Analyses continuous time system using the mathematical tools like Fourier and Laplace transform.	U, An, A
CO-03	Analyses discrete time system Z-transform as mathematical tool.	U, E, S
CO-04	Analyses discrete time system DTFT as mathematical tool and understand the properties of LTI system.	U, R
CO-05	Creates filter structures.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	L	S	S	S	L	S	S	S	N	M
CO-02	S	M	S	L	S	S	S	L	S	S	S	N	M
CO-03	S	M	S	L	S	S	S	L	S	S	S	N	M
CO-04	S	M	S	L	S	S	S	L	S	S	S	N	M
CO-05	S	S	S	L	S	S	S	L	S	S	S	N	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: REPRESENTATION OF SIGNALS AND ITS CLASSIFICATION 9

Signal-definition- Continuous and discrete time signals- Standard signals-unit impulse – unit step impulse functions- unit ramp- Real and complex exponential- sinusoidal signals – Classification of Signals – Deterministic and random- Periodic and aperiodic- even and odd – energy and power signals.

UNIT II: SYSTEM CLASSIFICATION AND ANALYSIS OF CONTINUOUS TIME SYSTEM 9

System- definition- Types of system- linear and nonlinear-causal and noncausal- Time variant and time invariant-static and dynamic- stable and unstable system- Fourier Transform-properties- computation of Fourier transform for standard signals- Laplace Transform- properties computation of Laplace transform for standard signals.

UNIT III: ANALYSIS OF DISCRETE TIME SYSTEM USING Z-TRANSFORM 9

Basic principles of z-transform - z-transform definition – region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform using Contour integration - Residue Theorem and Partial fraction expansion, Relationship between z- transform and Fourier transform.

UNIT IV ANALYSIS OF DISCRETE TIME SYSTEMS USING DTFT: 9

Discrete time fourier transform (DTFT) – Properties- Linear time invariant system properties- commutative- distributive- associative- Causality-Stability- Invertibility-memory and memoryless LTI system- unit step response of LTI system.

UNIT V: BLOCK DIAGRAM REPRESENTATION OF CONTINUOUS AND DISCRETE TIME SYSTEM 9

Representation of a CT system using differential equation- Representation of a DT system using Difference equation- Computation of impulse response and transfer function using Laplace transform and Z-transform- Convolution sum- Systems with finite duration and infinite duration impulse response – recursive and non-recursive discrete time system – realization structures – direct form – I, direct form – II, Transpose, cascade and parallel forms.

TOTAL: 45 HOURS

TEXT BOOK

1. Allan V. Oppenheim, S. Wilsky and S. H. Nawab, “Signals and Systems”, 2nd Edition, Pearson, 2015.

REFERENCES

1. P. Ramesh babu, “Signals and Systems”, 5th Edition, Scitech Publications India Pvt.Limited,2018.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, “Signals & Systems - Continuous and Discrete”, 4th Edition, Pearson, 2007.
3. John Alan Stuller, “An Introduction to Signals and Systems”, 1st Edition, Thomson, 2007.

BM3211	BIO-MATERIALS AND IMPLANTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the characteristics of Biomaterials and biocompatibility.
- To study about the different metals and ceramics used as biomaterials for biomedical applications
- To learn about polymeric materials and combinations that could be used as a tissue replacement implants
- To study the artificial organs developed using these materials

Course Outcome		Cognitive Skill
CO-01	Describe the characteristics and classification of bio materials	U, R
CO-02	Learn the host reactions to biomaterials	U, An, A
CO-03	Analyze the applications of biomaterials in devices and implants	U, E, S
CO-04	Understand the testing standards applied for biomaterials	U, R
CO-05	Understand the concept of artificial organs and developing the implants	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	L	L	M	M	M	S	S	S	L	S
CO-02	S	M	S	L	L	M	M	L	S	S	M	L	S
CO-03	S	S	S	L	L	S	M	L	S	S	M	L	S
CO-04	M	S	S	L	L	S	M	L	M	S	M	L	M
CO-05	S	S	S	L	L	S	M	L	M	S	M	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY 9

Definition and structure of bio-materials, Properties and characterization of bio- Materials, body response to implants, Protein adsorption, Biofilm formation, blood compatibility. Classes of materials used in medicine, Bioresorbable and Biodegradable Materials, composites thin films, grafts, Coatings medical fabrics and Biologically functional materials, Smart materials, Nano bio materials.

UNIT II HOST REACTIONS TO BIOMATERIALS 9

Inflammation, Wound healing and the Foreign body response. Systemic toxicity and Hypersensitivity. Blood coagulation and Blood-material Interactions. Tumorigenesis, implant associated infection. Degradation of materials in the biological environment, Skin substitutes

UNIT III APPLICATIONS OF BIO- MATERIAL IN DEVICES AND IMPLANT 9

Cardiovascular medical devices, Dental implants, Ophthalmologic applications- intraocular lens implants, Soft-tissue replacements, surgical tapes, adhesive, percutaneous and skin implants, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

UNIT IV STANDARDS AND REGULATIONS FOR MEDICAL IMPLANT 9

Sterilization of implants and Devices; Failure of implants and Devices, Performance of drug delivery systems, Standards development and regulation of medical products using biomaterials, testing of biomaterials: In vitro & In vivo assessment of tissue compatibility, Testing of blood-materials interactions.

UNIT V ARTIFICIAL ORGANS 9

Artificial Heart, Artificial Kidney, Bionic eyes, Artificial lungs, Artificial pancreas, Bionic ear.

TOTAL: 45 HOURS

TEXT BOOKS

1. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
2. Buddy D. Ratner, Frederick J. Schoen, Biomaterials Science: An Introduction to Materials in Medicine Allan S. Hoffman, Jack E. Lemons, Academic Press, 2004
3. Hench L LEthridgc E.C. Biomaterials, an interfacial approach, Academic Press, 1982

REFERENCES

1. Bronzino J D, the biomedical engineering handbook CRC Press.
2. Shayne Cox Gad (ed.) 2nd Edition, Safety Evaluation of Medical Devices, MarcelDekker Inc., New York, 2002.

BM3212	MICROPROCESSOR AND MICROCONTROLLER IN MEDICAL APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the architecture and programming of 8085 microprocessor.
- To introduce the interfacing of peripheral devices with 8085 microprocessor.
- To introduce the architecture and programming of 8051 microcontroller.
- To introduce the architecture and programming of Atmega 328 Microcontroller.
- To introduce the architecture and programming of Raspberry Pi Microcontroller.

Course Outcome		Cognitive Skill
CO-01	Know the architecture and programming of 8085 microprocessor.	U, R
CO-02	Understand the interfacing of peripheral devices with 8085 microprocessor.	U, An, R
CO-03	Know the architecture and programming of 8051 microcontroller.	U, E, S
CO-04	Know the architecture and programming of Atmega 328 Microcontroller.	U, R
CO-05	Understand the architecture and programming of Raspberry Pi Microcontroller.	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	S	S	M	S	M	S	M	S	M	S
CO-02	M	S	M	S	M	S	M	S	S	S	M	S	M
CO-03	S	M	S	M	S	S	S	S	S	M	S	S	S
CO-04	S	S	M	S	S	S	L	S	M	S	S	S	S
CO-05	S	S	M	S	M	S	S	S	S	M	N	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: 8085 ARCHITECTURE 9

8085 Architecture – Instruction set – Addressing modes – Timing diagrams – Assembly language programming – Counters – Time Delays – Interrupts – Memory interfacing – Interfacing, I/O devices.

UNIT II: PERIPHERALS INTERFACING 9

Interfacing Serial I/O (8251)- parallel I/O (8255) –Keyboard and Display controller (8279) – ADC/DAC interfacing – Inter Integrated Circuits interfacing (I²C Standard)-Bus: RS232C-RS485-GPIB

UNIT III: 8051 MICROCONTROLLER 9

8051 Micro controller hardware- I/O pins, ports and circuits -External memory - Instruction set -Addressing modes-Interrupts - Interrupt programming - Assembly language programming.

UNIT IV: ATMEGA 328 MICROCONTROLLER 9

Atmega 328 Microcontroller hardware- I/O pins, ports and circuits-architecture, Arduino UNO board with Atmega 328 Microcontroller-basic programming.

UNIT V: RASPBERRY PI 9

Basic functionality of the Raspberry Pi board and its processor, setting and configuring the board, component overview. Programming the Raspberry pi: Introduction to python programming language, python programming environment, python expressions, strings, function, function arguments.

TOTAL: 45 HOURS

TEXT BOOKS

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4th Edition, Penram International Publishing, New Delhi, 2007. (Unit I, II)
2. Mohammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Asia, New Delhi, 2012. (Unit IV, V)
3. Steven F. Barrett , Arduino Microcontroller Processing for Everyone! (Synthesis Lectures on Digital Circuits and Systems) Paperback – 30 Aug 2013
4. Cookbook, Tim Cox, Raspberry pi for python programmers, Packt publishing Ltd., second revised edition, 2016.

REFERENCES

1. A.K. Ray and K.M. Burchandi, Intel Microprocessors Architecture Programming and Interfacing, McGraw Hill International Edition, 2000
2. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, Penram International Publishers (India), New Delhi, 2019.
3. Richard Blum, Arduino Programming in 24 Hours, Sams Teach Yourself (Sams Teach Yourself: In 24 Hours) 2014.
4. Eben Upton and Gareth halfacree, Raspberry Pi user guide, John Wiley & sons, 2016.

BM3213	BM3213 COMMUNICATION ENGINEERING FOR BIOMEDICAL	L	T	P	C
		3	0	0	3

OBJECTIVES

The student should be made to:

- Understand basics of communication engineering and analog communication systems.
- Apply digital communication techniques.
- Understands and applies concepts of multi-user radio communication.
- familiarize with source and Error control codes.
- Understand and apply the concept of computer networks.

Course Outcome		Cognitive Skill
CO-01	Understands basics of communication engineering and analog communication systems.	U, R
CO-02	Applies digital communication techniques.	U,An, R
CO-03	Understands and applies concepts of multi-user radio communication.	U, E,S
CO-04	Analyzes and applies Source and Error control coding.	U,An, R
CO-05	Creates computer networks for communication.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	S	S	S	S	L	S	M	M
CO-02	S	S	S	M	S	S	S	S	S	L	S	M	M
CO-03	S	S	S	M	M	S	S	S	S	L	S	M	M
CO-04	S	S	S	M	M	S	S	S	S	L	S	M	M
CO-05	S	S	S	S	M	S	S	S	S	S	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: ANALOG COMMUNICATION **9**

Introduction to Communication Systems -Elements of analog communication systems- Modulation – Types - Need for Modulation. Theory of Amplitude Modulation(AM) – Types of AM- Double side band, Single sideband, Vestigial sideband - Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems (AM – FM – PM).

UNIT II: PULSE AND DIGITAL COMMUNICATION **9**

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM). Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)– Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT III: MULTI-USER RADIO COMMUNICATION **9**

Global System for Mobile Communications (GSM) - Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Handover Techniques -Overview of multiple Access Schemes - Satellite Communication - Bluetooth.

UNIT IV: INFORMATION THEORY AND ERROR CONTROL CODING **9**

Measure of information – Entropy – Source coding theorem – Shannon–Fano coding, Huffman Coding– Channel capacity – Shannon-Hartley law – Shannon’s limit – Error control codes – linear block codes, Cyclic codes– Convolution Coding, Sequential and Viterbi decoding.

UNIT V NETWORKING BASICS **9**

Uses of computer networks-Types of Networks-LAN, WAN, PAN, LAN topologies-Reference models-OSI model- TCP/IP Model, Examples of network-Internet-Wireless LANs:802.11-RFID and sensor networks, Protocols and Standard, Packet switching, circuit switching

TOTAL:45 HOURS

TEXT BOOK

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2006
2. Andrew S. Tanenbaum, “COMPUTER NETWORKS”, 5th Edition, Pearson Education India, 2013.

REFERENCES

1. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education, 2009.
2. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education India, 2010.
3. Behrouz A. Forouzan, “Computer Networks: A Top - Down Approach”, 1st Edition, McGraw Hill Education, 2017.

BM3276	LINEAR INTEGRATED CIRCUITS FOR BIOMEDICAL LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To introduce the working of different amplifiers.
- To introduce the working of Integrator and Differentiator.
- To introduce the working of Instrumentation amplifier.
- To introduce the working of Modulators
- To introduce the working of A/D and D/A Convertor

Course Outcome		Cognitive Skill
CO-01	The students will learn the design and working of different amplifiers.	U, R
CO-02	To know about the design and working of Integrator and Differentiator.	U,An, R
CO-03	To know about the design and working of Instrumentation amplifier.	U, E,S
CO-04	The students will know about the working of AM Modulator and FSK Modulator	U, R
CO-05	Familiarized with the working of A/D Convertor and D/A Convertor	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	S	S	S	S	M	S	S	M	N	S
CO-02	S	M	S	S	M	S	S	S	S	M	S	S	S
CO-03	S	S	M	S	S	M	S	M	S	S	S	M	L
CO-04	M	S	S	S	M	S	M	L	S	S	M	S	S
CO-05	S	M	M	S	M	N	M	S	S	S	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Design and testing of:

1. Inverting and Non inverting amplifiers.
2. Differential amplifiers.
3. Integrator
4. Differentiator.
5. Instrumentation amplifier.
6. Astable Multivibrators using op-amp.
7. Schmitt Trigger using op-amp.
8. Phase shift oscillator using op-amp.
9. Astable operation using IC 555 Timer.
10. Study of PLL characteristics.
11. AM Modulator
12. FSK Modulator
13. A/D Convertor
14. D/A Convertor

TOTAL: 30 HOURS

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CS32D1	Fundamentals of Artificial Intelligence	3	0	0	3
2.	BM3214	Medical Imaging Equipment	3	0	0	3
3.	BM3215	Diagnostic and Therapeutic Equipment	3	0	0	3
4.	BM3216	Bio-Signal Processing	3	0	0	3
5.	BM32**	Department Elective-I	3	0	0	3
6.	XXXX	Open Elective-II	3	0	0	3
PRACTICAL						
7.	BM3278	Medical Imaging Equipment Laboratory	0	0	3	1
8.	BM3279	Bio-Signal Processing Laboratory	0	0	3	1
9.	BM3280	Diagnostic and Therapeutic Equipment Laboratory	0	0	3	1
10.	BM32P2	Summer Internship II	0	0	0	2
TOTAL			18	0	9	23

CS32D1	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

OBJECTIVES

- Understand the basic concepts of intelligent agents.
- Develop general-purpose problem-solving agents, logical reasoning agents, and agents that reason under uncertainty.
- Employ AI techniques to solve some of today's realworld problems

Course Outcome		Cognitive Skill
CO-01	Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings.	U
CO-02	Choose appropriate algorithms for solving given AI problems	A
CO-03	Design and implement logical reasoning agents	R, A
CO-04	Design and implement agents that can reason under uncertainty	R, A
CO-05	Understand the basic areas of artificial intelligence including problemsolving, knowledge representation, reasoning, decision making, planning, perception and action.	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	S	L	S	S	S	S	S	S
CO-02	S	M	S	S	S	S	S	S	S	M	S	S	S
CO-03	S	S	M	S	S	M	S	S	S	S	S	S	S
CO-04	M	S	M	L	M	S	S	M	S	S	S	M	S
CO-05	S	M	M	S	M	S	M	S	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: AI AGENTS **9**

Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents – Problem solving agents – Search algorithms – Uninformed search strategies.

UNIT II: PROBLEM SOLVING **9**

Heuristic search strategies – heuristic functions – Local search and optimization problems – Local search in continuous space – Search with non-deterministic actions – Search in partially observable environments – Online search agents and unknown environments.

UNIT III: THEORY OF GAME PLAYING **9**

Game theory – Optimal decisions in games – Alpha-beta search – Monte-Carlo tree search – Stochastic games – Partially observable games.

Constraint Satisfaction Problems – Constraint propagation – Backtracking search for CSP – Local search for CSP – Structure of CSP.

UNIT IV: KNOWLEDGE BASED LOGICAL AGENTS **9**

Knowledge-based agents – Propositional logic – Propositional theorem proving – Propositional model checking – Agents based on propositional logic.

First-order logic – Syntax and semantics – Knowledge representation and engineering – Inferences in first-order logic – Forward chaining – Backward chaining – Resolution.

UNIT V: KNOWLEDGE REPRESENTATION **9**

Onto logical engineering – Objects and categories – Events – Mental objects and Modal logic – Reasoning systems for categories – Reasoning with default information.

Classical planning – Algorithms for classical planning – Heuristics for planning
Hierarchical planning – Non-deterministic domains – Time, Schedule, and Resources – Analysis.

TOTAL : 45 HOURS

TEXT BOOKS

1. Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020.

REFERENCES

1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007.
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008.
3. Patrick H. Winston, “Artificial Intelligence”, Third edition, Pearson Edition, 2006.
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013.
5. Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases - by Dennis Rothman, 2018.

BM3214	MEDICAL IMAGING EQUIPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the techniques of X-Ray.
- To study the CT.
- To study MRI.
- To study nuclear medical imaging systems SPECT and PET.
- To study thermal imaging systems.

Course Outcome		Cognitive Skill
CO-01	Understand the basic principle and working of x-ray machine medical imaging using advanced image modalities: MRI, CT and PET-CT	U, R
CO-02	Know the basic principle and working of CT	U, An, R
CO-03	Understand the basic principle and working of MRI.	U, E, S
CO-04	Understand the basic principle and working of nuclear medical imaging systems SPECT and PET.	U, R
CO-05	Know the basic principle and working of thermal imaging systems.	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	M	S	M	M	S	M	S	M	S
CO-02	S	S	M	M	S	S	S	S	M	M	S	S	M
CO-03	S	M	S	S	S	S	M	S	S	M	S	S	S
CO-04	M	S	S	S	S	M	S	L	S	L	S	M	S
CO-05	S	S	S	M	M	S	M	N	M	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT: I X-RAY AND X-RAY BASED MACHINES 9

Basis of Diagnostic Radiology - Nature of X-Rays-Production of X-rays - X-ray Machine — Visualization of X-rays, Digital radiography, Dental X Ray Machines, Mamographic X-Ray equipment, Fluoroscopy.

UNIT: II COMPUTED TOMOGRAPHY 9

Computed Tomography, Basic principle, System Components, viewing system processing systems-gantry geometry-Patient Dose in CT Scanners.

UNIT: IIIMRI IMAGING TECHNIQUES AND RADIATION DETECTORS 9

Principles of NMR Imaging Systems. Image reconstruction techniques, NMR Components- Biological effects of NMR Imaging-Advantages of NMR Imaging System.

UNIT: IV NUCLEAR MEDICAL IMAGING SYSTEMS 9

Radio-isotopes in Medical Diagnosis-The Gamma Camera-Emission Computed Tomography(ECT)-Single-Photon Emission Computed Tomography(SPECT) - Positron Emission Tomography (PET Scanner).

UNIT: V THERMAL IMAGING SYSTEMS 9

Medical Thermography, Physics of Thermography, Infrared Detectors, Thermographic Equipment, Quantitative Medical Thermography-Analog analysis and Digital analysis system, Pyroelectric Vidicon Camera, Thermal Camera Based on IR Sensor with Digital Focal Plane Array.

TOTAL: 45 HOURS

TEXT BOOKS

1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.

REFERENCES

1. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, Fourth edition 2010.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, Second edition 2003.

BM3215	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study Ultrasonography.
- To study measurement of parameters related to cardiology.
- To learn about various techniques of diathermy.
- To analyze neural and muscular activities.
- To study the different respiratory measurement system.

Course Outcome - COs		Cognitive Skill
CO-01	The students will know display techniques of ultrasonography and its medical applications. They will also learn about different medical devices.	U, An
CO-02	The students will learn about the working of cardiac equipment.	R,U
CO-03	The students will know the clinical application of diathermic principles.	R,U
CO-04	The students will understand the working of EEG, EMG its applications.	U,An
CO-05	Understand the concept of ventilators and other respiratory equipment.	U,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO -E	PO -F	PO -G	PO -H	PO -I	PO -J	PO -K	PO -L	PO -M
CO-01	S	M	M	M	S	M	L	M	S	S	M	M	S
CO-02	S	M	M	M	S	M	L	M	S	M	S	M	S
CO-03	S	S	M	M	S	M	L	M	S	S	M	M	S
CO-04	S	M	M	M	S	M	L	M	S	S	S	M	S
CO-05	S	M	M	M	S	M	L	M	S	M	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: ULTRASONOGRAPHY AND SPECIAL DEVICES 9

Basic pulse-echo technique, display techniques A, B and M mode, Doppler ultrasound, Application of ultrasound as diagnostic tool – Echocardiogram - abdomen - obstetrics and gynecology – ophthalmology, Laparoscopy, ICU/CCU Equipment, Audiometers– pure tone - speech audiometer and impedance audiometry

UNIT II: CARDIAC EQUIPMENT 9

Electrocardiograph, Normal and Abnormal Waveform, Heart rate monitor, Arrhythmia Simulator, Holter Monitor, Phonocardiography, Plethysmography, Cardiac stress testing Cardiac Pacemaker- Internal and External Pacemaker–Batteries, AC and DC Defibrillator- Internal and External, Echocardiograph, Cath Lab-Angiography – Angioplasty, Heart-Lung machine-Oxygenator- types – blood pumps - types

UNIT III: DIATHERMY 9

Short wave diathermy, Ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms - Tissue Responses - Electro surgical current level Blood flowmeters- Electromagnetic-Ultrasonic-Doppler blood flowmeters. Wearable health monitors, IR and UV lamp and its application

UNIT IV: NEUROLOGICAL EQUIPMENTS AND SKELETAL MUSCULAR SYSTEM 9

Clinical significance of EEG, Multi channel EEG recording system, Epilepsy, Evoked Potential – Visual - Auditory and Somatosensory, Sleep Studies - Polysomnography, Sleep apnoea monitors, MEG (Magneto Encephalon Graph), EEG Bio Feedback Instrumentation.

Sliding theory of contraction, recording and analysis of EMG waveforms, fatigue characteristics, muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation.

UNIT V: RESPIRATORY MEASUREMENT SYSTEM 9

Spirometer-Lung Volumes and capacities, measurements of residual volume, pneumotachometer – Airway resistance measurement, Whole body plethysmography, Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor.

Types of Ventilators – Pressure – Volume - Time controlled - Flow, Humidifiers, Nebulizers, Inhalators.

TOTAL: 45 HOURS

TEXT BOOK

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, Third Edition, 2013.
2. John.G.Webster, ”Medical Instrumentation: Application and Design”, John Wiley and sons, New York, 4th edition, 2001.
August 1997

REFERENCE

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”, John Wiley and sons, New York, 1997.

UNIT I DISCRETE FOURIER TRANSFORM**9**

Review of signals and systems- summary of analysis & synthesis equations for Fourier transform & discrete time Fourier transform- Discrete Fourier transform (DFT) - properties of DFT – periodicity- symmetry- Computation of DFT using formula- Linear convolution- Circular convolution- Sectioned convolution- overlap save and overlap add method- Fast Fourier transform- Decimation-in-time (DIT) algorithm, Decimation-in-frequency (DIF)algorithm.

UNIT II DESIGN OF NON-RECURSIVE(FIR) FILTERS**9**

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows -Rectangular, Hamming, Hanning, Blackman, Kaiser window- Frequency sampling method. FIR filter structures - linear phase structure.

UNIT III DESIGN OF RECURSIVE (IIR) FILTERS**9**

Characteristics of practical frequency selective filters-LPF-HPF-BPF-BSF- Analog filters- Analog low pass filter design- Butterworth approximation- Chebyshev approximation- type-I filter-pole location-type-II filter- analog frequency transformation – IIR filter design- Impulse invariance method- Bilinear transformation method.

UNIT IV NOISE CANCELLATION AND EEG SIGNAL ANALYSIS**9**

Adaptive filters – Principle noise canceller model – 50 Hz adaptive cancelling using a sine wave model – Maternal ECG cancellation in fetal electrocardiography – ECG cancellation in EMG recording – High frequency noise cancellation in Electro surgery- EEG signal characteristics – EEG analysis - time and frequency domain methods parametric model –Phenomenological model – linear prediction theory – Autoregressive method.

UNIT V ECG SIGNAL PROCESSING**9**

ECG QRS detection Techniques – Estimation of R-R interval – Estimation of ST segment inclination – Arrhythmia analysis monitoring – Long term ECG recording – Basics of ECG data reduction techniques.

TOTAL: 45 HOURS**TEXT BOOKS**

1. John G. Proakis& Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, 4th Edition, Pearson, 2007.
2. DC Reddy, “Biomedical Signal Processing – Principles and Techniques”, Tata McGraw Hill Publishing company Ltd., 2007.

REFERENCES

1. P. RameshBabu, “Digital Signal Processing”, 6th Edition, Scitech publications, 2015.
2. Andreas Antoniou, “Digital Signal Processing”, 1st Edition, Tata Mc Graw Hill, 2006.
3. Rangaraj M.Rangayyan, “Biomedical Signal Analysis ”, 2nd Edition, John Wileypublications,2015.

BM3278	MEDICAL IMAGING EQUIPMENTS LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

To study the main parts and working principle of X-Ray and CT machines.

To study the main parts and working principle of Thermograph.

To study the main parts and working principle of SPECT, PET

To study the main parts and working principle of CT, MRI, nuclear medical imaging systems

Course Outcome		Cognitive Skill
CO-01	Understand the production of x-rays, their characteristics and their role in the imaging process.	U, R
CO-02	Student will know the basic principles of medical imaging and involves equipment design and function, the image formation process on radiographic film and digital imaging plates.	U, An, R
CO-03	Understand the layout of catheterization laboratory and the procedure of angiography.	U, E, S
CO-04	Student will acquire relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Medical Imaging Technology	U, R
CO-05	Understand the role of exposure factors and the effects on image quality and the special imaging modalities	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	M	M	S	S	M	S	S	S	M	S	M
CO-02	S	M	M	S	S	S	S	S	S	M	S	S	S
CO-03	S	S	M	S	S	M	S	S	S	S	S	S	M
CO-04	L	S	L	S	M	S	S	M	S	S	S	M	S
CO-05	N	M	M	S	M	S	M	S	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

- 1 Study of X-Ray machine.
- 2 Study of portable X-Ray machine.
- 3 Study of Dental X-Ray machine.
- 4 Study of Mammograph
- 5 Study of Thermograph.
- 6 Study of SPECT imaging.
- 7 Study of PET imaging.
- 8 Study of MRI imaging.
- 9 Study of CT imaging.
- 10 Study the importance of gamma camera in Imaging.
- 11 Study of detectors used in Imaging Equipment.
- 12 Study of radiation dosimeter.

▪ **TOTAL: 30 HOURS**

BM3279	BIOSIGNAL PROCESSING LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

- Understand standard signals in continuous and discrete time domain.
- Gain knowledge on mathematical operations of signals to detect repeating patterns and to calculate the output of a linear time invariant system.
- Understand the working of adaptive filters in minimizing the noise in biomedical signals.
- Design recursive and non-recursive filters using Butterworth and Chebyshev approximation.
- Understand the use of FFT in removing noise from biomedical signals.

Course Outcome		Cognitive Skill
CO-01	Generates continuous and discrete time signals.	U, R
CO-02	Detects repeating patterns in signals and evaluates the output of a LTI system.	U,An, R
CO-03	Designs an adaptive filter to minimize noise.	U, E,S
CO-04	Designs frequency selective filters using Butterworth and Chebyshev approximation.	U, R
CO-05	Capable of removing noise from ECG and EMG signals.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	S	S	S	S	S	M	S	S
CO-02	S	S	S	M	S	S	S	S	S	S	M	S	S
CO-03	S	S	S	M	S	S	S	S	S	S	M	S	S
CO-04	S	S	S	M	S	S	S	S	S	S	M	S	S
CO-05	S	S	S	S	S	S	S	S	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. To generate continuous and discrete time standard like signals like unit impulse, step, ramp and sinusoidal signals.
2. To perform linear convolution of two signals.
3. To perform circular convolution of two signals.
4. To perform autocorrelation of a sequence.
5. To perform cross correlation of two sequences.
6. To obtain the frequency response of FIR and IIR filter.
7. To perform up and down sampling.
8. To perform noise cancellation using LMS adaptive filter.
9. To perform noise cancellation using RLS adaptive filter.
10. To perform FFT of a sequence.
11. Implementation of FFT for ECG Signal using MATLAB.
12. EMG signal Processing using MATLAB.

TOTAL: 30 HOURS

BM3280	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

- To demonstrate the working of diagnostic equipment.
- To examine different therapeutic modalities.

Course Outcome		Cognitive Skill
CO-01	Describe the working. Principle and operation of different types of medical equipment's	U, R
CO-02	Demonstrate various diagnostic and therapeutic techniques.	U,An, R
CO-03	Design and implement the instrumentation modules of medical equipment.	U, E,S
CO-04	Understand the working of EEG, EMG biofeedback its applications.	U, R
CO-05	Analyse different medical device models using suitable tools.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO -A	PO -B	PO -C	PO -D	PO -E	PO -F	PO -G	PO -H	PO -I	PO -J	PO -K	PO -L	PO -M
CO-01	S	M	M	M	S	S	M	S	S	S	S	S	M
CO-02	S	M	M	S	S	S	S	S	S	M	S	S	S
CO-03	S	M	M	S	S	S	S	S	S	S	S	S	M
CO-04	S	M	L	S	S	S	S	S	S	S	S	M	S
CO-05	S	M	M	S	S	S	M	S	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Study of shortwave diathermy.
2. Study of ultrasonic diathermy.
3. Measurement of respiratory parameters using spirometry.
4. Study of EEG, EMG biofeedback instrumentation.
5. Analyse the working of ESU – cutting and coagulation modes
6. Recording of audiogram.
7. Study of defibrillator.
8. Study of pacemaker.
9. Study of ventilators.
10. Study of heart lung machine model.
11. Study of Cath lab equipment.
12. Study of ultrasonography.

TOTAL: 30 HOURS

SEMESTER-VII

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	BM3217	Medical Image Processing	3	0	0	3
2.	BM3218	Virtual Instrumentation for Biomedical	3	0	0	3
3.	BM32**	Department Elective-V	3	0	0	3
4.	MS3202	Principles of Management	2	0	0	2
5.	BM32**	(Department Elective-VI)	3	0	0	3
PRACTICAL						
6.	BM3281	Medical Image Processing Lab	0	0	2	1
7.	BM3282	Virtual Instrumentation for Biomedical Lab	0	0	2	1
8.	BM32P3	Project Work Phase –I	0	0	6	3
TOTAL			14	0	10	19

MS3202	PRINCIPLES OF MANAGEMENT	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To introduce students to the basic concepts and functions of management.
- To understand the role and responsibilities of managers in various organizational settings.
- To develop an understanding of the planning, organizing, leading, and controlling functions of management.
- To examine the impact of management theories and practices on organizational performance.
- To equip students with the skills necessary to manage people and processes effectively in a technical environment.

Course Outcome – Cos		Cognitive Skill
CO-01	Define and explain the key concepts and functions of management.	U, R
CO-02	Analyse the roles and responsibilities of managers in different organizational contexts.	An
CO-03	Apply planning, organizing, leading, and controlling principles to real-world scenarios.	A
CO-04	Evaluate the effectiveness of different management theories and practices.	E
CO-05	Demonstrate management skills necessary for leading teams and projects in a technical environment.	A

R- Remember, U-Understand, A-Apply, An-Analyse, E-Evaluate, S- Synthesis

Unit I: Introduction to Management

7

Definition, nature, and importance of management - Functions of management: Planning, Organizing, Leading, Controlling - Roles and skills of managers - Evolution of management thought: Classical, Behavioural, and Modern theories - Scientific Management (Taylor) - Administrative Theory (Fayol) - Human Relations Movement (Mayo) - Contemporary approaches (Systems Theory, Contingency Theory)

Unit II: Planning

5

Nature and purpose of planning - Types of plans: Strategic, Tactical, Operational - Planning process and techniques - SWOT Analysis, SMART Goals, Scenario Planning - Decision making: Process, types, and tools- Rational Decision-Making Model - Bounded Rationality - Group Decision-Making Techniques (Brainstorming, Delphi Technique)

Unit III: Organizing

5

Organizational structure and design - Types of organizational structures: Functional, Divisional, Matrix, Network - Authority, responsibility, and delegation - Coordination and communication within organizations - Formal and Informal Communication Channels - Role of Technology in Organizational Communication (Emails, Video Conferencing, Collaborative Tools)

Unit IV: Leading

7

Leadership theories and styles - Trait Theory - Behavioural Theories (Ohio State Studies, Michigan Studies) - Contingency Theories (Fiedler's Model, Path-Goal Theory) - Transformational vs. Transactional Leadership - Motivation theories and practices, Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, McClelland's Theory of Needs, Modern Approaches (Self-Determination Theory) - Group dynamics and team management - Stages of Team Development (Forming, Storming, Norming, Performing) - Managing Virtual Teams

Unit V: Controlling

6

Nature and purpose of control - Control process and techniques, Establishing Standards, Measuring Performance, Correcting Deviations - Types of control: Feed forward, Concurrent, Feedback - Quality control and management, Total Quality Management (TQM), Six Sigma, Lean Management, Use of Data Analytics in Quality Control.

TOTAL: 30 PERIODS

TEXTBOOKS :

1. Robbins, S. P., Coulter, M., & DeCenzo, D. A. (2020). *Fundamentals of Management* (11th ed.). Pearson.
2. Griffin, R. W. (2022). *Management: Principles and Practices* (12th ed.). Cengage Learning.
3. Jones, G. R., & George, J. M. (2021). *Essentials of Contemporary Management* (9th ed.). McGraw-Hill Education.

REFERENCES:

1. Daft, R. L. (2021). *Management* (14th ed.). Cengage Learning.
2. Bateman, T. S., & Snell, S. A. (2020). *Management: Leading & Collaborating in a Competitive World* (14th ed.). McGraw-Hill Education.
3. Schermerhorn, J. R. (2021). *Management* (14th ed.). Wiley.
4. Hill, C. W. L., Schilling, M. A., & Jones, G. R. (2020). *Strategic Management: Theory & Cases* (13th ed.). Cengage Learning.
5. Kinicki, A., & Williams, B. K. (2021). *Management: A Practical Introduction* (10th ed.). McGraw-Hill Education.

BM3217	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES

- Introduce the fundamentals of Digital Image Processing.
- To obtain an insight on the application of image processing techniques for medical images and its importance.
- Deal with various methods of acquisition of medical images and diagnostic methods.

Course Outcome		Cognitive Skill
CO-01	Understand the different parts of medical imaging systems and its working principle	U, R
CO-02	Gain expertise in the fundamentals of Digital Image Processing, especially analysis techniques.	U,An, R
CO-03	Implement the image processing techniques using intensity transformations and spatial filtering	U, E,S
CO-04	Get through knowledge on image restoration and work on recent analysis techniques for medical image application.	U, R, A
CO-05	Evaluate the segmentation and edge linking of general image processing methods for medical images and should provide own innovative algorithms competing the performance.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	S	S	S	S	L	M	M	S	M	M
CO-03	S	S	S	M	S	M	S	L	S	S	S	S	S
CO-04	M	S	M	M	M	S	S	L	M	M	S	M	M
CO-05	S	S	S	S	S	M	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: DIGITAL IMAGE FUNDAMENTALS

9

Examples of fields that use digital image processing, Fundamental steps in digital image processing, components of an image processing system, Applications of Digital image processing. Image sensing and acquisition, image sampling and quantization, representing digital images, basic relationships between pixels.

UNIT II: IMAGE TYPES AND IMAGE FILE FORMATS

9

Image Types- Binary images, Gray scale images, Color image, Volume image, Range image, Multispectral image, Volumetric Data, X-Ray images, CT images, MRI images.
Image file formats – GIF file format, JPEG, PNG, TIFF, and BMP.

UNIT III: INTENSITY TRANSFORMATIONS AND SPATIAL FILTERING

9

Basics of intensity transformation and spatial filtering, Basic intensity transformation functions, Piecewise - Linear Transformation functions, histogram processing - histogram equalization, histogram matching, enhancement using arithmetic and logic operators, basis spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods.

UNIT IV: IMAGE RESTORATION

9

A model of the image degradation/restoration process, noise models, restoration in the presence of noise-only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function.

UNIT V: SEGMENTATION AND EDGE LINKING

9

Segmentation methods, thresholding, edge detection, Laplacian, Sobel, Roberts cross, canny edge, Edge Linking and Boundary Detection – Local Processing- Regional Processing- Global Processing using Hough transform.

TOTAL: 45 HOURS

TEXT BOOKS

1. Digital Image Processing by Rafael C Gonzalez and Richard E Woods, 3rd edition, PHI learning Private Limited 2008.
2. Digital Image Processing by S.Jayaraman, S Esakkirajan, T Veerakumar- Tata McGraw Hill -2009.
3. The physics of Medical Imaging – S.Webb-Taylor and Francis Sep 2010.
4. 3D Image Processing: Techniques and Clinical Applications, A.L.Baert , D. Caramella, C. Bartolozzi, 2002.
5. MRI for Technologists – Peggy Woodward, Mc.Graw – Hill Medical Publications Nov 2000.

REFERENCES

1. Computed Tomography Imaging, Jagat Narula, Stephan Achenbach, Takeshi Kondo, 2012.
2. Fundamentals of Digital Image Processing- Anil.K.Jain, Prentice Hall, Englewood Cliffs, New Jersey , 2008.
3. Fundamentals of Medical Imaging – Paul Suetens, Cambridge University Press- 2002.
4. Medical Image Processing Concepts, Sinha G.R,2014.
5. Medical Image Processing: Techniques and Applications, Geoff Dougherty, 2011.

BM3218	VIRTUAL INSTRUMENTATION FOR BIOMEDICAL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To review background information required for studying virtual instrumentation.
- To study the basic building blocks of virtual instrumentation.
- To study the various techniques of interfacing of external instruments of PC.
- To study the various graphical programming environment in virtual instrumentation.
- To study a few applications in virtual instrumentation.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamental concepts in Virtual Instrumentation.	U, R
CO-02	Gain knowledge about the Lab VIEW software.	U,An, R
CO-03	Understand the programming techniques used in Virtual Instrumentation.	U, E,S
CO-04	Able to learn the principles of data acquisition and instrument control.	U, R, A
CO-05	Acquire knowledge about the advanced lab VIEW and its applications.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	M	S	S	S	S	M	S	L	M	M	M	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	S	S	S
CO-04	S	S	M	M	M	S	S	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION**9**

Virtual Instrumentation and Lab VIEW – Evolution of Lab VIEW - Difference between Lab View and conventional languages-Sequencing and data flow- Graphical programming

UNIT II: LABVIEW ENVIRONMENT**9**

Front panel-Block diagram-Icon and Connector – Control Palette-Function Palette-ToolsPalette- Creating, editing, wiring, debugging and saving VIs- sub - VIs-creating sub-VIs- simple examples-Looping: For loop, while loop-Shift registers- case and sequence; structures,formula nodes

UNIT III: PROGRAMMING TECHNIQUES**9**

Arrays-clusters, charts and graphs, string and file I/O, Display types – Digital – Analog – Chart – Oscilloscopic types, local and global variables-property node

UNIT IV: DATA ACQUISITION AND INSTRUMENT CONTROL**9**

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

UNIT V: ADVANCED Lab VIEW AND APPLICATIONS**9**

Connectivity in Lab VIEW: an introduction- IVI – Lab windows/CVI-Applications of Lab VIEW: process control, physical, biomedical, Image acquisition and processing.

TEXT BOOKS

1. Sanjeev Gupta, ‘Virtual Instrumentation using Labview’ Tata McGraw Hill, 2004.
2. Gary Johnson, ‘Lab view graphical programming’, II Ed., McGraw Hill, 1999.

REFERENCE

1. Lisa K Wells & Jeffrey Travels, ‘Lab view for everyone’, Prentice Hall, 2003.
2. Jovitha Jerome ‘Virtual Instrumentation using Lab View’ PH1 Learning Pvt Ltd, 2009.

BM3281	MEDICAL IMAGE PROCESSING LAB	L	T	P	C
		0	1	2	2

OBJECTIVES

- Introduce the fundamentals of Digital Image Processing.
- Application of those techniques for Medical images and its importance.
- Deal with various methods of Acquisition of Medical images and Diagnostic methods.

Course Outcome		Cognitive Skill
CO-01	Gain expertise in the fundamentals of Digital image processing, especially analysis Techniques.	U, R
CO-02	Implement the image processing techniques using MATLAB.	U,An, R
CO-03	Evaluate the performance of general image processing methods for medical images and should provide own innovative algorithms competing the performance.	U, E,S
CO-04	Provide an understanding of the principles of medical image processing and give practical experience realizing them using an image processing package.	U, R, A
CO-05	Provide an appreciation of how medical image analysis contributes to current practice and research in medical imaging.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	S	S	S	L	M	M	M	M	M
CO-03	S	S	S	M	S	S	S	L	S	S	S	S	S
CO-04	S	S	M	M	M	S	S	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

LIST OF EXPERIMENTS

- 1) Gray level Transformation-Image negatives,
- 2) Image subtraction of Medical Images (CT & MRI)
- 3) Contrast Enhancement of medical images
- 4) Histogram techniques applied to X-Ray, CT and PET images.
- 5) Filtering- Low pass and High pass filters for CT Images.
- 6) Filtering- Low pass and High pass filters for MRI Images.
- 7) Designing an FIR filter using window techniques.
- 8) Perform the inverse filter of the given image.
- 9) Edge detection using different edge detectors.
- 10) Arithmetic operations on images.
- 11) Logical operations on images.
- 12) Image segmentation of MRI Images

TOTAL: 45 HOURS

BM3282	VIRTUAL INSTRUMENTATION FOR BIOMEDICAL LAB	L	T	P	C
		0	1	2	2

OBJECTIVES

1. To understand the basics of virtual instrumentation concept and data flow.
2. To understand the various functions available in Lab view for engineering process.
3. To able to design the projects using the functions available in lab view.
4. To understand about the interfacing of DAQ devices and customized user designed hardware with lab view.
5. To write the certified Lab view associate development exam (CCAD) administered by National Instruments, for the certification and leading placement companies.

Course Outcome		Cognitive Skill
CO-01	Understand the basics of virtual instrumentation concept and data flow.	U, R
CO-02	Understand the various functions available in Labview for engineering process.	U,An, R
CO-03	Able to design the projects using the functions available in labview.	U, E,S
CO-04	Understand about the interfacing of DAQ devices and customized user designed hardware with labview.	U, R, A
CO-05	Write the certified Labview associate development exam (CCAD) administered by National Instruments, for the certification and leading placement companies.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	S	S	S	S	L	M	S	M	M	M
CO-03	S	S	S	M	S	S	M	L	S	S	S	S	S
CO-04	M	S	M	M	S	S	S	L	M	M	S	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

LIST OF EXPERIMENTS

- 1 Creating Virtual Instrumentation for simple (Addition, Subtraction, Division, Multiplication) Applications
- 2 Programming exercises for loops and charts
- 3 Programming exercises for clusters and graphs.
- 4 Programming exercises on case and sequence structures, file Input / Output.
- 5 Data acquisition through Virtual Instrumentation.
- 6 Developing voltmeter using DAQ cards.
- 7 Developing signal generator using DAQ cards.
- 8 Simulating reactor control using Virtual Instrumentation.
- 9 Real time temperature control using Virtual Instrumentation.
- 10 Developing a Stepper Motor control using Labview.
- 11 Developing a PID Simulator using Labview.
- 12** Image acquisition and processing using Lab view.

TOTAL: 45 HOURS

BM32P3	Project Work Phase –I	L	T	P	C
		0	0	6	3

OBJECTIVES

- Improve the interpersonal and communication skills and awareness about the industrial needs.
- Development of presentation skills.
- Select and apply appropriate solution methodology to solve Biomedical engineering problems
- Students also show the ability to formulate, conduct, analyse and interpret experiments and apply experimental results to improve diagnosis in biomedical field.

Course Outcome		Cognitive Skill
CO-01	Undertake problem identification, formulation and solution, Conceptualise a novel idea / technique into a product.	U, R
CO-02	Take on the challenges of teamwork, prepare a presentation in a professional manner and document all aspects of design work.	U, An, R
CO-03	Design engineering solutions to complex problems utilizing a systems approach.	U, E, S
CO-04	Communicate with engineers and the community at large in written and oral forms.	U, R, A
CO-05	Demonstrate the knowledge, skills and attitudes of a professional engineer.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	M	S	S	S	M	S	L	M	S	M	M	M
CO-03	S	S	S	M	S	S	S	L	S	S	S	S	S
CO-04	S	S	M	M	S	S	S	L	M	M	M	M	M
CO-05	S	S	M	S	S	S	S	L	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

DESCRIPTION

The primary objective of this course is to develop in student the capacity for analysis, judgment and the ability to carry out independent investigation in design/development through a project work involving creativity, innovation and ingenuity. The topic of the proposed project work along with brief summary shall have to be approved by the Department. The work must start with comprehensive literature survey and critical appreciation thereof so as to select the research problem. Around 40% of the project work should be completed in the seventh semester. The remaining 60% work will be carried out in the Eighth semester. Each student is required to submit a detailed report about the work done on the topic of project as per the guidelines decided by the department. The report shall be evaluated internally through presentations and viva-voce during the semester end as per the guidelines decided by the department from time to time. If a candidate chooses any co-supervisor from outside the university then prior permission from the HOD is required on the recommendation of internal supervisor(s). The external co-supervisor, if any, must be an eminent person from the reputed institution/organization/industry etc. and also to be approved by the department.

SEMESTER VIII

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	BM32**	Department Elective-IX	3	0	0	3
2.	OEC	Open Elective-VIII/ Swayam/MOOC Course	3	0	0	3
PRACTICAL						
3	BM3283	Hospital Visit	0	0	2	2
4.	BM32P4	Project Work Phase –II	0	0	24	8
TOTAL			6	0	26	16

BM3283	HOSPITAL VISIT	L	T	P	C
		0	0	2	2

OBJECTIVES

- To understand the scope of health care services and health policies.
- To familiarize the medical device working standards, maintenance procedures.
- To know the need of biomedical engineers in research and development.

Course Outcome		Cognitive Skill
CO-01	Identify the need and significance of Biomedical Engineering and health policies.	U, R
CO-02	Appreciate the need for standard and quality management in hospitals.	U, An, R
CO-03	Apply the knowledge of computer and information technology in health care.	U, E, S
CO-04	Appraise the code of ethics in design and development.	U, R, A
CO-05	Evaluate device safety and ensure a secure hospital environment.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	M	S	S	L	M	M	M	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	S	S
CO-04	S	S	M	M	M	S	S	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

DESCRIPTION

Provide Training to the students on challenges in Hospital equipment maintenance, Hospital Administration and Planning. It helps in developing leaders for solving problems in current issues of technology development, health care services, Telemedicine, Bio-Medical Waste Management and rural healthcare

BM32P4	Project Work Phase –II	L	T	P	C
		0	0	24	12

OBJECTIVES

- The projects undertaken span a diverse range of topics, including theoretical, simulation and experimental studies.
- The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.
- An exposure to various electrical and electronic systems of Biomedical Instruments
- Understand the engineering relationships between Human Factors and Engineering and task design
- Understand the basic concepts and broad principles of biomedical projects

Course Outcome		Cognitive Skill
CO-01	Analyze, synthesize, and interpret various engineering designs.	U, R
CO-02	Enable the students for project planning and implementation	U, An, R
CO-03	Get capable of self-education and clearly understand the value of achieving perfection in project implementation and completion.	U, E, S
CO-04	Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context	U, R, A
CO-05	Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
S	S	L	M	S	M	S	L	S	S	S	S	S	S
S	S	S	S	S	M	S	M	M	M	S	M	M	S
S	M	S	M	S	S	S	L	S	S	M	S	S	S
S	S	M	M	M	S	M	L	M	M	M	M	M	S
S	S	S	S	S	S	S	L	S	M	M	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Description

Final year projects represent the culmination of study towards the Bachelor of Engineering degree. Assessment is by means of a seminar presentation, submission of a thesis, and a public demonstration of work undertaken. Around 40% of the project work should be completed in the seventh semester. The remaining 60% work will be carried out in the 8th semester. Each student is required to submit a project on research work carried out by him/her as per guidelines decided by the department which will be evaluated by the external examiner. The student is also required to submit progress reports during the semester and will deliver pre-submission seminar before final submission of project as per guidelines decided by the department from time to time. In case of unsatisfactory performance of the candidate as evaluated Internally/Externally, the candidate have to repeat and improve his performance. A candidate may carry out his/her project work outside the University with prior permission from the HOD with recommendation of the internal supervisor(s). The external co-supervisor, if any, must be an eminent person from the reputed institution/organization/industry etc. and also to be approved by the department.

LIST OF ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32A1	Medical Informatics	3	0	0	3
2	BM32A2	Soft Computing Techniques	3	0	0	3
3	BM32A3	Rapid Prototyping	3	0	0	3
4	BM32A4	Biomechanics	3	0	0	3
5	BM32A5	Neural Engineering	3	0	0	3
6	BM32A6	Medical Robotics	3	0	0	3
7	BM32A7	Drug Delivery Systems and Implantable Devices	3	0	0	3
8	BM32A8	Biomedical Monitoring Equipment's	3	0	0	3
9	BM32A9	Biometric Systems	3	0	0	3

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32B1	Bio-MEMS	3	0	0	3
2	BM32B2	Tissue Engineering and R-DNA technology	3	0	0	3
3	BM32B3	Hospital Engineering and Management	3	0	0	3
4	BM32B4	Advanced Virtual Instrumentation	3	0	0	3
5	BM32B5	Tele Medicine	3	0	0	3
6	BM32B6	Biomedical in Sports	3	0	0	3
7	BM32B7	Artificial Organs	3	0	0	3

OPEN ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32D5	Robotics in Healthcare	3	0	0	3
2	BM32D6	Medical Optics	3	0	0	3
3	BM32D7	Computers in Medicine	3	0	0	3
4	BM32D8	Medical Equipment's Manufacturing Guidelines and Policies	3	0	0	3
5	BM32D9	Intellectual Property Rights	3	0	0	3
6	BM32E1	Rehabilitation Engineering	3	0	0	3
7	BM32E2	Bio fluids and Dynamics	3	0	0	3
8	BM32E3	Hospital System Management	3	0	0	3

BM32A1	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Understand fundamental characteristics of data, information, and knowledge in the Health Informatics domain.
- Provide all students with basic skills and knowledge in health informatics to apply in their future health-related careers.
- Become familiar with common algorithms for health applications and IT components in representative clinical processes.
- Develop understanding of population health and precision medicine.
- Understand basic principles of knowledge management systems in biomedicine.

Course Outcome		Cognitive Skill
CO-01	Become familiar with the basic definitions, key concepts, terminology, and historical context of Medical Informatics.	U, R
CO-02	Know the basic principles of computerized patient record.	U, R
CO-03	Understand the applications of computers in clinical laboratory and medical imaging.	U, E, S
CO-04	Student will acquire relevant appropriate and adequate technical knowledge in computer-assisted medical decision-making.	U, R
CO-05	Understand the recent trends in medical informatics.	U, R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	M	S	M	S	S	S	S	M	S	S
CO-02	S	M	S	S	S	S	S	S	M	M	S	S	S
CO-03	S	S	M	S	S	M	S	S	S	S	S	S	M
CO-04	L	S	L	M	M	S	S	M	S	S	S	M	S
CO-05	M	M	M	S	M	S	M	S	S	M	M	S	L

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: MEDICAL INFORMATICS**9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services, Health Informatics – Medical Informatics, Bioinformatics

UNIT II: COMPUTERISED PATIENT RECORD**9**

Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

UNIT III: COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING**9**

Automated clinical Laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging ultrasonography-computed X-ray tomography, Radiation therapy and planning, NuclearMagnetic Resonance

UNIT IV: COMPUTER ASSISTED MEDICAL DECISION-MAKING**9**

Neuro computers and Artificial Neural Networks application, Expert system - General model of CMD, Computer –assisted decision support system-production rule system cognitivemodel, semester networks, decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing

UNIT V: RECENT TRENDS IN MEDICAL INFORMATICS**9**

Medical Expert Systems, Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery computer aids for the handicapped, computer assisted, instrumentation in Medical Informatics - virtual Hospitals – SmartMedical Homes – Personalized e-health services –GRID and Cloud Computing in Medicine

TEXT BOOKS

1. R.D.Lele Computers in medicine progress in medical informatics, Tata Mcgraw Hill, Publishing computers Ltd, 2005, New Delhi.
2. Mohan Bansal, Medical informatics Tata Mcgraw Hill Publishing Computers Ltd, 2003. New Delhi.

REFERENCE BOOKS

1. N.Mathivanan, “PC-Based Instrumentation”, Prentice Hall of India Pvt Ltd – NewDelhi, 2007.
2. Yi – Ping Phoebe Chen, “Bioinformatics Technologies”, Springer International Edition, New Delhi, 2007.

BM32A2	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES

To Improve Data Analysis Solutions.

- To strengthen the dialogue between the statistics and soft computing research communities in order to cross-pollinate both fields and generate mutual improvement activities.
- To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems.
- Identify and select a suitable Soft Computing technology to solve the problem.

Course Outcome		Cognitive Skill
CO-01	Learn soft computing techniques and their applications.	U, R
CO-02	Understand various neural network architectures.	U, An, R
CO-03	Know the fuzzy systems.	U, S
CO-04	Understand the genetic algorithm concepts and their applications.	U, R
CO-05	Apply Hybrid Systems for designing intelligent systems.	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	S	S	M	S	S	S	M	S	S
CO-02	S	M	S	S	S	S	S	S	S	M	S	S	S
CO-03	S	S	M	S	S	M	S	S	S	S	S	S	M
CO-04	M	S	M	M	M	S	S	M	S	S	S	M	S
CO-05	M	M	M	S	M	S	M	S	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION TO SOFT COMPUTING

9

Introduction-Artificial Intelligence-Artificial Neural Networks-Fuzzy Systems-Genetic Algorithm and Evolutionary Programming-Swarm Intelligent Systems-Classification of ANNs-McCulloch and Pitts Neuron Model-Learning Rules: Hebbian and Delta- Perceptron Network-Adaline Network-Madaline Network.

UNIT II: ARTIFICIAL NEURAL NETWORKS 9

Back propagation Neural Networks - Kohonen Neural Network -Learning Vector Quantization -Hamming Neural Network - Hopfield Neural Network- Bi-directional Associative Memory -Adaptive Resonance Theory Neural Networks- Support Vector Machines - Spike Neuron Models.

UNIT III: FUZZY SYSTEMS 9

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

UNIT IV: GENETIC ALGORITHMS 9

Basic Concepts- Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion -Mutation Operator - Bit-wise Operators -Convergence of Genetic Algorithm.

UNIT V: HYBRID SYSTEMS 9

Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

TOTAL: 45 HOURS

TEXT BOOKS

1. N.P.Padhy, S.P.Simon, "Soft Computing with MATLAB Programming", OxfordUniversity Press, 2015.
2. S.N.Sivanandam , S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt.Ltd., 2ndEdition, 2011.
3. S.Rajasekaran, G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and GeneticAlgorithm, Synthesis and Applications ", PHI Learning Pvt.Ltd., 2017.
4. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and SoftComputing",PearsonEducation, 2004.

REFERENCES

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, -Neuro-Fuzzy and SoftComputing, Prentice-Hall of India, 2008.
2. Kwang H.Lee, -First course on Fuzzy Theory and Applications, Springer, 2005.
3. James A. Freeman and David M. Skapura, -Neural Networks Algorithms, Applications,and Programming Techniques, Addison Wesley, 2003.

BM32A3	RAPID PROTOTYPING	L	T	P	C
		3	0	0	3

OBJECTIVES

This is desirable to ensure that all the expected requirement of product is addressed and if required, its performance is also assessed from the prototype.

Rapid prototyping offers a convenient option for manufacturing of product or its prototype from the CAD model.

Course Outcome		Cognitive Skill
CO-01	Understand and apply fundamentals of rapid prototyping techniques.	U, R
CO-02	Use techniques for processing of CAD models for rapid prototyping.	U, An, R
CO-03	Understand the CAD processes and materials for rapid prototyping.	U, E, S
CO-04	Use appropriate tooling for rapid prototyping process.	U, R
CO-05	Understand the errors in RP processes and rp applications	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	M	M	S	M	M	S	S	S	M	S	S
CO-02	S	M	M	S	S	S	S	S	M	M	S	S	S
CO-03	S	S	M	S	S	M	S	S	S	S	S	S	M
CO-04	L	S	L	S	M	S	S	M	S	S	S	M	S
CO-05	N	M	M	S	S	S	M	S	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

BM32A4	BIOMECHANICS	3	0	0	3
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OBJECTIVES

The objective of this course is to enable the student to

- Learn the fundamental concepts of the principles of mechanics.
- Review the mechanical properties of musculoskeletal elements.
- Study the biomechanics of joints and implants.
- Learn the application of biomechanics.
- Understand the basics of biofluid mechanics

Course Outcome		Cognitive Skill
CO-01	Understand and apply the principles of mechanics, in the context of biological systems	U, R
CO-02	Apply the knowledge of biomechanics into analysis of human joints and motion	U, An, R
CO-03	Describe the mechanical properties of musculoskeletal elements to develop the mathematical models of joints and implants.	U, E, S
CO-04	Apply Biomechanics principles to “real-world” problem and describe their impact on health, safety, society, environment as well as underlying legal and ethical considerations.	U, R
CO-05	Appraise the basics of biofluid mechanics as applied to heart valve design and blood vessel models.	E, U, A, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	M	S	M	L	M	S	S	M	M	S
CO-02	S	M	M	M	S	M	L	M	S	M	S	M	S
CO-03	S	S	M	M	S	M	L	M	S	S	M	M	S
CO-04	S	M	M	M	S	M	L	M	S	S	S	M	S
CO-05	S	M	M	M	S	M	L	M	S	M	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION TO MECHANICS

9

Introduction – Scalars and vectors, Statics –Resolution and composition of forces, Moments, couple, Resultant, equilibrium of coplanar forces, Dynamics – Linear motion, Newton's laws of motion, Velocity and acceleration, Kinematics – Models, Transducers Constitutive equations –Non-viscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

UNIT II: BIOMECHANICS OF JOINTS

9

Free-body diagrams and equilibrium, Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

UNIT III: MUSCULOSKELETAL MECHANICS

9

Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling; Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling. Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voigt models

UNIT IV: BIOMECHANICS AND ERGONOMICS

9

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; models for voice biomechanics, Ergonomics –Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted and whole-body vibrations.

UNIT V: BIOFLUID MECHANICS

9

Intrinsic fluid properties, Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube, Structure of blood vessels, Material properties and modelling of Blood vessels, Heart – Cardiac muscle characterization, Native heart valves, Prosthetic heart valve fluid dynamics.

TOTAL: 45 HOURS

TEXT BOOKS

1. Y.C. Fung, Bio-Mechanics- Mechanical Properties of Tissues, Springer-Verlag, 1998.
2. Subrata Pal, Textbook of Biomechanics, Viva Books Private Limited, 2009
3. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, Biofluid Mechanics: The Human Circulation, Taylor and Francis, 2007.
4. Özkaya, Nihat, Dawn Leger, David Goldsheyder, and Margareta Nordin. Fundamentals of biomechanics: equilibrium, motion, and deformation. Springer, 2016.

REFERENCES

1. Sheraz S. Malik and Shahbaz S. Malik, Orthopaedic Biomechanics Made Easy, Cambridge University Press, 2005.
2. Jay D. Humphrey, Sherry De Lange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer Science Business Media, 2004.
3. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.

BM32A5	NEURAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

The student should be made to:

- To be familiar with the nervous system development
- To be exposed to neuronal diseases and disorders
- To be familiar with nerve reconstruction and repairing

Course Outcome		Cognitive Skill
CO-01	Explain the basic structure and functions of human nervous system.	U, R
CO-02	Understand diseases and degeneration related to nervous system.	U,An, R
CO-03	Analyze visualization and radiological assessment of nervous system.	U, E,S
CO-04	Apply neural tissue engineering for rehabilitation.	U, R
CO-05	Discuss about Regeneration of nervous system	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	M	M	S	M	L	M	S	S	M	M	S
CO-02	S	M	M	M	S	M	L	M	S	M	S	M	S
CO-03	S	S	M	M	S	M	L	M	S	S	M	M	S
CO-04	S	M	M	M	S	M	L	M	S	S	S	M	S
CO-05	S	M	M	M	S	M	L	M	S	M	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: BASICS OF NEURON STRUCTURE AND FUNCTIONS 9

History of Ideas about Brain, Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.

UNIT II: BRAIN, BRAIN STEM AND SPINAL CORD 9

Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation

UNIT III: NEURONAL DISEASES AND DISORDERS 9

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer's, Parkinson's and Prion diseases

UNIT IV: NEUROPHYSIOLOGY 9

Emotions in the Brain, Multilayer Perceptrons , Applications in Psychology and Neuroscience, Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system.

UNIT V: NERVE RECONSTRUCTION AND REHABILITATION 9

Maps in the Brain, Memories and Holograms, Consciousness, Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering;

Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuro motor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation

TOTAL: 45 HOURS

TEXT BOOKS

1. Mathews G.G., "Neurobiology", 2nd edition, Blackwell Science, UK, 2000
2. Malcom Carpenter, "Textbooks of Neuroanatomy", Mc. Graw hill Edition, 1996

REFERENCES

1. W. Mark Saltzman, "Tissue Engineering – Engineering principles for design of replacement organs and tissue", Oxford University Press Inc New York, 2004.
2. Park J.B., "ACS Biomaterials Science and Engineering", Plenum Press, 2014. Saunders, 2006

BM32A6	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Identify and describe different types of medical robots and their potential applications
- Know basic concepts in kinematics, dynamics, and control relevant to medical robotics
- Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions
- Be familiar with the state of the art in applied medical robotics and medical robotics research
- Understand the various roles that robotics can play in healthcare

Course Outcome		Cognitive Skill
CO-01	Ability to understand different types of Robotic Systems.	U, R
CO-02	Ability to apply the concepts of robotics for surgery.	U,An, R
CO-03	Ability to analyse the positioning and orientation of medical robots.	U, E,S
CO-04	Ability to design the kinematics model for a specified robotic system.	U, R
CO-05	Understand Robotic systems for Medical application.	E, U,A,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	M	m	S	S	m	M	S	M	S	I
CO-02	M	S	S	M	S	S	S	S	S	S	M	S	S
CO-03	S	S	M	M	S	M	S	S	S	M	S	S	M
CO-04	S	S	S	M	S	S	S	S	S	S	M	S	S
CO-05	S	S	S	S	S	S	S	S	L	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I : INTRODUCTION

9

Automation and Robots, Classification, Application, Specification, Notations. Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, four axis robot, Six-axis robot)

UNIT II: INVERSE KINEMATICS

9

General properties of solutions tool configuration five axis robots, Three- Four axis, Six axis robot (Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.

UNIT III: ROBOT VISION

9

Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, structured illumination, Camera calibration).

UNIT IV: TASK PLANNING**9**

Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.

UNIT V: APPLICATIONS**9**

Applications in Biomedical Engineering, Application in rehabilitation, Application in Clinical and Surgery, Modern trends in Robotic surgery

TOTAL: 45 HOURS**TEXT BOOKS**

1. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall, 2003.
2. J.J.Craig, Introduction to Robotics, Pearson Education, 2005.

REFERENCES

1. Staugaard, Andrew Robotics and Artificial Intelligence: An Introduction to Applied Machine Learning, Prentice Hall Of India, 1987.
2. Grover, Wiess, Nagel, Oderey, Industrial Robotics: Technology, Programming and Applications, McGraw Hill, 1986.
3. Wolfram Stadler, Analytical Robotics and Mechatronics, McGraw Hill, 1995.
4. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Prentice Hall, 2001.
5. K. S. Fu, R. C. Gonzales and C. S. G. Lee, Robotics, McGraw Hill, 2008.

BM32A7	DRUG DELIVERY SYSTEMS AND IMPLANTABLE DEVICES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know the fabrication, design, evaluation and application of drug delivery systems.
- To learn about polymeric materials and combinations that could be used as a tissue replacement implants
- To learn the different types of drug delivery systems.

Course Outcome		Cognitive Skill
CO-01	Understand the principles and technology used in the design of sustained release and controlled release drug delivery systems.	U, R
CO-02	Learn the criteria for selection of a drugs and polymers for the development of novel drug delivery systems.	U,An, R
CO-03	Understand the formulation and evaluation of novel drug delivery systems.	U, E,S
CO-04	Know the levels of Drug targeting.	U, R, A
CO-05	To know the structural activity relationship of different class of drugs.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	S	S	S	M	M	S	S	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	S	S
CO-04	M	S	M	S	M	S	M	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: FUNDAMENTAL CONCEPTS OF DRUG RELEASE 9

Drug release, controlled drug release, sustained release time, drug delivery systems. Prerequisites of drug candidates, various approaches and classification, dose calculation for controlled release. Brief introduction to polymers, parameters affecting selection of polymers for modified release systems.

UNIT II: NOVEL DRUG DELIVERY SYSTEMS (DDS) 9

Diffusion Controlled DDS, Water Penetration Controlled DDS, Chemically Controlled DDS Biodegradable Reservoir and Monolithic Systems, Responsive Smart Systems, Physically and Chemically Responsive Systems, Mechanical, Magnetic or Ultrasound Responsive Systems, Biochemically Responsive and Self-Regulated Systems, Particulate DDS

UNIT III: MICROENCAPSULATION 9

Introduction, concept of microencapsulation, merits, demerits and application, Types of microencapsulation: chemical encapsulation processes, complex, polymer-polymer incompatibility, interfacial polymerization, and in-situ polymerization, mechanical encapsulation process.

UNIT IV: IMPLANTABLE DEVICES 9

Cardiovascular medical devices, Dental implants, Ophthalmologic applications-intraocular lens implants, Soft-tissue replacements, surgical tapes, adhesive, percutaneous and skin implants, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

UNIT V STANDARDS AND REGULATIONS FOR MEDICAL IMPLANTS 9

Sterilization of implants and Devices; Failure of implants and Devices, Performance of drug delivery systems, Standards development and regulation of medical products using biomaterials, Testing of biomaterials and the medical implants: In vitro & In vivo assessment of tissue compatibility, Testing of blood-materials interactions

TOTAL: 45 HOURS

TEXTBOOKS

1. N.K. Jain, "Advances in Controlled and Novel Drug Delivery", CBS Publication, 2001.
2. Peter J. Tarcha, "Polymers for Controlled Drug Delivery", CRC Press, 1991.
3. Rakesh Tekade, "Drug Delivery Systems", first Edition, 2019.
4. Vinod Kumar Khanna, "Implantable Medical Electronics", 2015.
5. Ansel, Handbook "Drug delivery system", 2009.

REFERENCE BOOKS

1. Ratner-Hoffman, “Biomaterial Science: An Introduction to Materials in Medicine”, Elsevier Academic Press, 2004.
2. J.D. Bronzino, “The Biomedical Engineering Handbook”, CRC Press, 2000.
3. Shayne Cox Gad (ed.) 2nd Edition, Safety Evaluation of Medical Devices, Marcel Dekker Inc., New York, 2002.
4. BingheWang ,LongqinHu, Teruna J. Siahaan. Drug Delivery: Principles and Applications, Second Edition, 2016.

BM32A8	BIOMEDICAL MONITORING EQUIPMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the basic principles and working of patient monitoring system.
- To develop skills enabling Biomedical Engineers to serve the health care industry.
- To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.

Course Outcome		Cognitive Skill
CO-01	Provide a better understanding about various bioelectrical signal recorders and patient safety.	U, R
CO-02	Demonstrate the principles of electronics used in designing various biomedical monitoring equipment's.	U, An, R
CO-03	Provide a better understanding about foetal and neonatal monitoring systems.	U, E, S
CO-04	Acquire the ability to explain the various patient monitoring equipment's.	U, R, A
CO-05	Acquire in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care Equipment and the advanced technologies such as Telemetry and Telemedicine.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	M	S	S	S
CO-02	S	M	M	S	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	M	S
CO-04	S	S	M	M	M	S	M	M	M	M	S	M	M
CO-05	S	S	S	M	M	S	S	L	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: BIOMEDICAL RECORDERS**9**

ECG, Vector cardiograph, Phonocardiography, EMG and EEG, Digital Stethoscope, Measuring techniques for EOG, ERG and BCG.

UNIT II: ARRHYTHMIA AND AMBULATORY MONITORING INSTRUMENTS**9**

Cardiac Arrhythmias-waveforms and interpretation from them, Arrhythmia monitor, Stress test measurement, Ambulatory monitoring instruments-Holter monitor, Ambulatory ECG with wearable electrodes, Microwave Sensor based ambulatory monitoring, Implantable Cardiac Monitors, Ambulatory Blood Pressure Monitoring.

UNIT III: PATIENT MONITORING SYSTEMS**9**

Bedside patient monitoring systems, central monitors, cardiac monitors, Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Oximeters.

UNIT IV: FOETAL AND NEONATAL MONITORING SYSTEM**9**

Cardiotocograph, Methods of monitoring of Fetal Heart rate, Monitoring labor activity, Incubator and Infant warmer, Non-stress test monitoring.

UNIT V: BIO-TELEMETRY AND TELEMEDICINE**9**

General Telemetry System, Single channel and Multi-channel, Landline and Radio-frequency Telemetry, Telemedicine- its essential parameters, delivery modes and its Applications.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub), 2014.
2. Medical Instrumentation, Application and Design (Fifth Edition): J G. Webster. (John Wiley), 2020.
3. Biomedical Instrumentation and measurements (Second Edition) : Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer.(PHI Pub), 2014

REFERENCE BOOKS

1. Introduction to Biomedical Equipment Technology (4th Edition): Carr –Brown, Pearson Education India, Delhi, 2004.
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub), 2006.

BM32A9	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Understand the basic concepts of fingerprint, iris, face and speech recognition.
- Study the general principles of design of biometric systems and the underlying trade-offs
- Introduce the knowledge on personal privacy and security implications of biometrics based identification technology and the issues realized

Course Outcome		Cognitive Skill
CO-01	Infer the technologies of fingerprint, iris, face and speech recognition.	U, R
CO-02	Expertise in the general principles of design of biometric systems and the underlying trade-offs.	U, An, R
CO-03	Prioritize the work on identification and recognition depends on physiological and behavioral characteristics. Identify the interfacing technologies for real time biometric applications	U, E, S
CO-04	Inculcate knowledge on personal privacy and security implications of Biometrics based identification technology and the issues involved.	U, R, A
CO-05	Know the Biometric applications in the field of medicine	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	S	S	L	S	S	S	S	S
CO-02	S	M	M	S	S	M	S	M	M	M	S	M	M
CO-03	S	S	S	M	S	S	S	L	S	S	M	S	S
CO-04	S	M	M	M	M	S	M	L	M	S	S	M	M
CO-05	S	S	S	M	S	S	S	L	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: BIOMETRIC FUNDAMENTALS

9

Biometrics versus traditional techniques – Characteristics - Key biometric processes - Verification – Image processing/pattern recognition- filtering- edge detection- smoothening-enhancement- Biometric matching - Performance measures in biometric systems - Assessing the privacy risks of biometrics.

UNIT II: IMAGE PROCESSING FUNDAMENTALS

9

Convolution- linear/non-linear filtering- Special filters- enhancement filter- edge detection- Laplacian. Unsharp masking- high boot filtering- sharpening special filtering- thresholding- localization- Robert's method- Sobal's method- Canny edge detection- Positive/negative identification- Biometric system security Authentication protocols- Authentication methods.

UNIT III: PHYSIOLOGICAL BIOMETRICS CHARACTERISTICS 9

Facial scan - Ear scan, Retina scan -Iris scan - Finger scan - automated fingerprint identification system - Palm print - Hand vascular geometry analysis - DNA - Dental.

UNIT IV: BEHAVIORAL BIOMETRICS CHARACTERISTICS 9

Signature scan - Keystroke scan - Voice scan, Gait recognition - Gesture recognition - Face recognition.

UNIT V: BIOMETRIC INTERFACES 9

Human machine interface - BHMI structure, Human side interface: Iris image interface - Hand geometry and fingerprint sensor - Machine side interface - Parallel port - Serial port - Network topologies, Biometric Applications.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Ruud M. Bolle et al, "Guide to Biometrics", Springer, USA, 2004 Edition.
2. Richard O Duda, David G. Strok, Peter E hart, "Pattern Classification" (2nd Edition), Wiley , 2000.
3. Rafael C. Gonzalez, Richard Eugene Woods, "Digital Image Processing using MATLAB", McGraw Hill 2010

REFERENCE BOOKS

1. Anil K. Jain, Arun Ross, and Karthik Nandakumar, "Introduction to biometrics", 2011
2. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005
3. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach" Prentice Hall, 2005

BM32B1	BIO MEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn modern miniaturization techniques and its application in biomedical engineering
- Expected Outcome Fundamentals of MEMS technology, biosensors and BIOMEMS.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamentals of Bio-MEMS.	U, R
CO-02	Analyze the criteria for design of Bio-MEMS.	U,An, R
CO-03	Understand the various diagnostic and therapeutic applications of Bio-MEMS.	U, E,S
CO-04	Understand the recent advancements in the field of Microelectronics.	U, R, A
CO-05	Learn about the properties of materials used in Bio-MEMS.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	S	S	S	M	M	S	S	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	S	S
CO-04	M	S	M	S	M	S	M	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION**9**

Historical background of Micro Electro Mechanical Systems, Types of MEMS devices, MEMS Microsystems, Integrated MEMS and Microsystems.

UNIT II: MATERIALS AND PROCESSES**9**

Materials used in MEMS, Properties of silicon, fabrication techniques, lithography, etching, wafer bonding, bulk and surface micromachining, Thin film deposition.

UNIT III: BIOSENSORS**9**

Different types of biosensors, Detection techniques: optical, electrical, mechanical, SPR based. Specific examples: glucose sensor, urea sensor. Enzyme immobilization techniques.

UNIT IV: MICROFLUIDS AND BIOCHIPS**9**

Fundamentals of microfluidics, Lab-on-a-chip devices, Silicon and glass micromachining for micro total analysis systems. Biochips and their applications in medical treatment.

UNIT V: APPLICATIONS OF BIOMEMS**9**

MEMS devices for diagnostics, drug delivery, implantable devices, shape memory implants, MEMS for neurosurgery, Microneedles.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Fundamentals of microfabrication, 2nd Edition, by Marc Madou
2. Fundamentals of semiconductor fabrication. Gary S. May and Simon Sze
3. Therapeutic Micro/Nano technology, Tejal Desai and Sangeeta Bhatia (editors).

REFERENCES

1. Lab-on-a-chip. R. Edwin Oosterbroek and Albert van den Berg (editors).
2. Shape Memory Implants. L'HocineYahia (editor)
3. Sensors in biomedical applications. Gabor Harsanyi.
4. Sensors in medicine and healthcare. Oberg, Togawa and Spelman

BM32B2	TISSUE ENGINEERING AND R-DNA TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study about the role of stem cell technology in biology.
- To study about R-DNA technology and its application in biomedical field.
- Significance of scaffold design in fabrication of different biological tissues.

Course Outcome		Cognitive Skill
CO-01	Gain knowledge in tissue characterization methods and their clinical implementation.	U, R
CO-02	Familiarize with the recombinant DNA technology.	U,An, R
CO-03	Brief the methods and tools associated with recombinant DNA technology.	U, E,S
CO-04	Understand the correlation between genotypic and phenotypic attributes of an organism.	U, R, A
CO-05	Understand the performance of genetic manipulations using types of cloning and expression vectors.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	M	S	M	M	L	S	S	M	S	S
CO-02	S	S	M	S	M	M	S	M	M	S	S	M	M
CO-03	S	M	S	M	M	S	S	L	S	S	M	S	S
CO-04	S	S	S	M	M	M	M	L	M	M	S	M	M
CO-05	S	M	S	M	S	S	S	L	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: HISTORICAL PERSPECTIVE OF TISSUE ENGINEERING

9

Historical perspective of tissue engineering industry and products, Cell sources, culture conditions, three dimensional interactions, cell reprogramming, Stem cells (embryonic), Stem cells (adult), Extracellular matrix. Stem cells and its applications.

UNIT II: ENGINEERING METHODS AND DESIGN AND CLINICAL IMPLEMENTATION

9

Tissue Biomechanics, Scaffold design and fabrication, Tissue Engineering of Skin, Bone, Cartilage, Neurons, Cardiovascular Tissue Engineering, Musculoskeletal system (tendon/ligament/muscle) and Adipose Tissue.

UNIT III: ISOLATION OF GENOMIC AND NUCLEAR DNA

9

Introduction to DNA, DNA digestion and restriction fragment analysis and sequencing by chemical, enzymatic and big-bye terminator methods.

UNIT IV: CLONING AND SUBCLONING STRATEGY**9**

Construction of recombinant DNA: Preparation of competent cell-Transformation, transfection – Recombinant selection and screening; Genomic DNA library; CDNA synthesis strategies – Linkers – Adapters – Homo polymer tailing.

UNIT V: SELECTION OF RDNA CLONES AND THEIR EXPRESSION PRODUCTS**9**

Direct and indirect methods. Drug resistance, gene inactivation, DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting).

TOTAL: 45 HOURS**TEXT BOOKS**

1. Biomaterials, artificial organs and Tissue engineering, Larry L. Hench, Julian.R Jones, Wood head publishing Ltd, 2005.
2. Principle of Tissue Engineering, Robert P.Lanza, Robert Langer William L.Chick. Academic Press, 2004.
3. “Principles of Gene Manipulation” by R.W. Old and S.B. Primrose 2002 Sixth Edition.
4. “Genes VI” by B.Lewin, 2012. IXth Eds. Oxford University.
5. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, Molecular Biology of the Cell, Garland Science Publishing (2008).
6. JE, Goldstein ES and Kilpatrick ST, Lewin’s GENES X, Jones and Bertlett Publishers (2011).

REFERENCES

1. Tissue Engineering, by Palsson and Bhatia (eds.), Published by Pearson Prentice Hall, 2004.
2. A. Hasan “Tissue Engineering for Artificial Organs”, 2017.
3. Keya Chaudhuri, “Recombinant DNA Technology”, 2013.
4. Dijana Plaseska Karanfilaska, Zoran Popovski, Bratislav Stankovic, “Recombinant DNA Technology and Genetic Engineering”, 2015.

BM32B3	HOSPITAL ENGINEERING AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To define the need and role to be performed by biomedical technical personnel in the hospital.
- To understand the management in healthcare and the importance of hospital management.
- To understand various standards used in the health care.
- To understand safety procedures followed in hospitals.

Course Outcome		Cognitive Skill
CO-01	Outline the design, operation, and maintenance of different employees of hospital waste treatment.	U, R
CO-02	Know the different Departments of Hospital units and its role.	U, An, R
CO-03	Understand the Management Information system and its application	U, E, S
CO-04	Understand health policies and standards	U, R, A
CO-05	Implement the Quality and Safety Aspects in Hospital.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	S	S	S	S	L	S	S	M	S	S
CO-04	S	S	M	M	S	S	M	L	M	S	M	M	M
CO-05	S	S	M	S	S	S	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: NEED AND SCOPE OF CLINICAL ENGINEERING

9

Clinical engineering profession, responsibilities, role to be performed by Biomedical Engineers in the hospital, staff structure in hospital, Difference between hospital and industrial organization, Difference between hospital and infirmary.

UNIT II: MANAGEMENT IN HOSPITAL

9

Health Care facility Design Methodology, Human Resource Management in Hospital– Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training, Job Description, Guidelines -Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer, Communication – nature, scope, barriers, styles and modes of communication.

UNIT III: HEALTH CARE IT

9

Computer Interface Techniques and Applications, Management Information system (MIS) – Lab information system, Finance management, Radiology Management System, Materials management and stores, Biomedical equipment's management, clinical management systems (Wards, ICU,s, OPD,IPD), DICOM,PACS.

UNIT IV: HEALTH POLICIES AND STANDARDS

9

Need for evolving health policy, health organization in state, health financing system, health education, health insurance, health legislation .Necessity for standardization, FDA, Healthcare Accreditation standards (ISO, JCI, NABH, NABL), ICRP and other standard organization, methods to monitor the standards.

UNIT V: QUALITY AND SAFETY ASPECTS IN HOSPITAL

9

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABH, JCI, NABL. Safety and Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Managing Health Care Quality– Medical Audit –Patient Safety Audits, Hazard and Safety Audits in a hospital Setup.

TEXT BOOKS

1. Antonio Valdevit, Vikki Hazelwood, Arthur B. Ritter, Alfred N. Ascione “Biomedical Engineering Principles”, Second Edition, 2004.
2. R.C. Goyal, Hospital Administration and Human Resource Management, PHI – Fourth Edition, 2006.
3. G.D. Kundurs, Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007
4. Francis Hegarty, John Amooore, Paul Blackett, “Healthcare Technology Management”, 2017.
5. Keith Willson , Keith Ison , SlavikTabakov “Medical Equipment Management”, 2013.

REFERENCE BOOKS

1. Arnold D. Kalcizony and Stephen M. Shortell, Health Care Management, 6th Edition Cengage Learning, 2011.
2. Modern Trends in planning and Designing of hospitals – Gupta S.K.Sunilkant Chandrasekhar. R Satpathy- Jaypee brothers – 2007.
3. Hospital and Nursing Homes Planning, Organizations& Management – Syed Amin Tabish – Jaypee brothers, New Delhi- 2003.
4. Hospitals, Facilities Planning and Management – G.D.Kunder-2008.

BM32B4	ADVANCED VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the different methods of data exchange.
- To understand the data security systems and its standards.
- To know the legal aspects of telemedicine.

Course Outcome		Cognitive Skill
CO-01	Understand basic knowledge of Evolution of LabVIEW and define those who could benefit from this technology.	U, R
CO-02	Basic ability to write coding and setting.	U,An, R
CO-03	Understand and apply different programme technique	U, E,S
CO-04	The application of data acquisition and instrument control .	U, R, A
CO-05	Know the importance advanced labview and applications .	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	L	M	L	M	S	M	S	L	S	S	S	M	S
CO-02	S	S	M	S	M	M	S	M	M	M	S	M	M
CO-03	S	M	S	S	M	S	M	L	S	L	M	S	S
CO-04	M	S	M	M	S	S	M	L	M	S	S	M	M
CO-05	S	S	S	M	S	S	S	L	S	M	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION**9**

Virtual Instrumentation and LabVIEW – Evolution of LabVIEW-Difference between. LabView and conventional languages-Sequencing and data flow- Graphical programming

UNIT II: LABVIEW ENVIRONMENT**9**

Front panel-Block diagram-Icon and Connector – Control Palette-Function Palette-ToolsPalette- Creating, editing, wiring, debugging and saving VIs- sub - VIs-creating sub-VIs- simple examples-Looping: For loop, while loop-Shift registers- case and sequence; structures,formula nodes

UNIT III: PROGRAMMING TECHNIQUES**9**

Arrays-clusters, charts and graphs, local and global variables-property node, string and file I/O.

UNIT IV: DATA ACQUISITION AND INSTRUMENT CONTROL**9**

DAQ-Components-Buffers: Buffered and non-buffered I/O-Triggering-Analog I/O- Digital I/O- Counters and timers-Instrument control: VISA, GPIB, VXI and PXI.

UNIT V: ADVANCED LabVIEW AND APPLICATIONS**9**

Connectivity in LabVIEW: an introduction- IVI – Lab windows/CVI-Applications of LabVIEW: process control, physical, biomedical, Image acquisition and processing.

TOTAL = 45 HOURS**TEXT BOOKS**

1. Sanjeev Gupta, 'Virtual Instrumentation using Labview' Tata McGraw Hill, 2004.
2. Gary Johnson, 'Lab view graphical programming', II Ed., McGraw Hill, 1999.

REFERENCE BOOKS

1. Lisa K Wells & Jeffrey Travels, 'Lab view for everyone', Prentice Hall, 2003.
2. Jovitha Jerome 'Virtual Instrumentation using Lab View' PH1 Learning Pvt Ltd, 2009.

BM32B5	TELE MEDICINE	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the different methods of data exchange.
- To understand the data security systems and its standards.
- To know the legal aspects of telemedicine.

Course Outcome		Cognitive Skill
CO-01	Understand basic knowledge of Telemedicine and Tele health and define those who could benefit from this technology.	U, R
CO-02	Basic ability to assess a patient in the ambulatory telemedicine setting.	U,An, R
CO-03	Utilization of Data Exchange methods required to present and manage the patient details to the doctors' location.	U, E,S
CO-04	The application of communication using Data Security and Standards.	U, R, A
CO-05	Know the importance of Ethical and legal aspects of Telemedicine.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	S	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	S	M	S	S	L	S	S	M	S	S
CO-04	S	S	M	M	S	S	M	L	M	S	S	M	M
CO-05	S	S	S	M	S	S	S	L	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: HISTORY OF TELEMEDICINE**9**

History of telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, organs of telemedicine, scope, Benefits, and limitations of telemedicine. Tele radiology: Definition, Basic parts of teleradiology system.

UNIT II: TYPE OF INFORMATION**9**

Types of telehealth solutions: Store and forward: Images and videos of health information, Mobile health: interactive and non-interactive - data logging and analysis - remote consultation, Remote patient monitoring: Vital signs real time monitoring and advice, Real time: Live 2way communication – interactive. Type of information; ISDN, Internet, GSM, 4 G and 5 G Network, wireless broad band,

UNIT III: DATA EXCHANGE**9**

Data Exchange: Network Configuration, circuit and packet switching, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN). Video Conferencing. Android IOS based apps for system integration and data transfer

Integration and operational issues: - system integration, store –and - forward operation, Real-time Telemedicine.

UNIT IV: DATA SECURITY AND STANDARDS**9**

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7. Controlled sampling security and confidentiality tools. Image Acquisition system, Display system, Communication Network, Interpretation section.

UNIT V: ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE**9**

Ethical and legal aspects of Telemedicine: Confidentiality, and the law, patient rights and consent, access to medical Records, Consent treatment, jurisdictional Issues, Tele surgery, Applications of Tele surgery, Tele cardiology, Tele oncology

TOTAL: 45 HOURS**TEXTBOOKS**

1. Shashi Gogia, Fundamentals of Telemedicine and Tele health, First Edition, 2019.
2. A.C. Norris, Essentials of Telemedicine and Tele care John Sons & Ltd, 2002.
3. Victor Lyuboslavsky, “Telemedicine and Tele health 2.0”, First Edition, 2015.
4. R.S.Khandpur, Telemedicine: Technology and Applications, 2017.

REFERENCES

1. E-Health, Tele health, and Telemedicine: A Guide to Startup and Success (Jossey-Bass Health Series) by Marlene M. Maheu-02 Jan 2010.
2. Telemedicine and Tele health: Principles, Policies, Performance and Pitfalls by Adam Darkins, Springer Publisher Company March 2000.

3. Richard Wootton, John Craig, Victor Patterson, Introduction to telemedicine, Second edition, 2006.
4. Marilyn J Field, Telemedicine: A Guide to Assessing Telecommunications for Health Care, Second edition 2007.

BM32B6	BIOMEDICAL IN SPORTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- This empowers the student with part of the knowledge they need to take on the role of a sports.
- To understand biomechanics that deal with different joints of Human body
- To understand various standards used in the health care.
- To understand the scope of health care services and health policies.

Course Outcome		Cognitive Skill
CO-01	Mechanics of head, neck, chest and abdominal	U, R
CO-02	Unite biomedical engineering with sports and medicine.	U,An, R
CO-03	Allowing the field to advance in materials with the creation of ergonomic prosthetics with biocompatible materials	U, E,S
CO-04	Implement monitoring systems for recovering injuries	U, R, A
CO-05	Mechanical bracing apparatus for weak joints, and more.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	S	M	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	M	S	S	L	M	S	M	S	S
CO-04	S	S	M	M	M	S	M	L	M	M	S	M	M
CO-05	S	M	S	M	S	M	S	L	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: MECHANICS OF SOFT TISSUE (TISSUE ENGINEERING) 9

Fundamentals of Soft Tissue Mechanics (Muscle Architecture, Max Muscle Stress, Max Muscle Contraction Velocity, Muscle Force-Length Relationship, Muscle Force Velocity Relationship, Tendon Biomechanics),

UNIT II: MECHANICS OF HEAD, NECK, CHEST AND ABDOMINAL 9

Mechanics of Head and Neck (Injury Mechanisms, Mechanical Response, Regional Tolerance, human substitutes for head and neck injury assessment), Biomechanics of Chest and Abdominal Impact(compression injury, acceleration injury, viscous injury, force injury, spine injury), Biomechanical Responses during Impact, Injury Risk Assessment.

Advanced impact biomechanics, crash injury prevention biomechanics, 3D rigid-body kinetics and analysis

UNIT III: BIOMECHANICS OF DIFFERENT JOINTS OF HUMAN BODY 9

Geometry of Articulating Surfaces, Joint Contact, Axes of Rotation of (Ankle, Knee, Elbow, Wrist), Tribology (Friction, Wear and Surface Damage), Hydrodynamic Lubrication Theories, Boundary Lubrication, Synovial Joints.

UNIT IV: GAIT ANALYSIS 9

Clinical Gait Analysis Information, Data Collection Protocol, Measurement Approaches and Systems (Stride and Temporal Parameters, Motion Measurement, Ground Reaction Measurement, Dynamic Electromyography)

UNIT V: PHYSIOLOGY IN SPORTS AND EXERCISE 9

Muscle Energetic, Cardiovascular Adjustments, Maximum Oxygen Uptake, Respiratory Responses, Optimization Techniques, Thermal Response, Applications

TOTAL: 45 HOURS**TEXT BOOKS**

1. Nordine-Frankel, "Basic Biomechanics of the Musculoskeletal System", Lea &Febiger, 1989.
2. Cappozzo-Berne, "Biomechanics of Human Movement: Applications in Rehabilitation, Sports and Ergonomics", Bertec Corporation, 1990

REFERENCE BOOKS

1. J. D. Bronzino, "Biomedical Engineering Handbook", 3rd ed, CRC Press, 2006.
2. Arthur T. Johnson, "Biomechanics and Exercise Physiology", John Wiley and Sons, 1991 .

BM32B7	ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Testing and control of prosthetic devices.
- Construction and evaluation of artificial organs.
- Standard and ethical issues related to various devices.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamentals of Artificial organs and analyse the criteria for design of Artificial organs.	U, R
CO-02	Apply the principles and design concepts of Artificial organs to solve critical medical problems.	U, An, R
CO-03	Design the prosthetics according to the patient's needs.	U, E, S
CO-04	Learn about various types of Artificial organs	U, R, A
CO-05	Learn about the properties of materials used in Artificial organs.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	M	S	S	S
CO-02	S	M	M	S	M	M	S	M	M	M	S	M	S
CO-03	S	M	S	M	M	S	S	L	M	S	M	S	S
CO-04	S	M	M	M	S	S	M	L	M	S	S	M	M
CO-05	S	S	S	M	S	S	M	L	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: DESIGN OF ARTIFICIAL ORGANS**9**

Substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs.

UNIT II: ARTIFICIAL HEART AND CIRCULATORY ASSIST DEVICES**9**

Design of Artificial heart, History of Artificial Heart, Types of Valve Prostheses, Thrombus Deposition, Durability, Mechanical Circulatory Assistance, Two Main Categories, Intra-Aortic Balloon Pump, Percutaneous Cardio-Pulmonary Bypass,

UNIT III: ARTIFICIAL LUNGS AND BLOOD GAS EXCHANGE DEVICES**9**

Gas Exchange Systems, Cardio Pulmonary Bypass, Comparison of Artificial Lungs and Natural Lungs, Oxygen Transport, Carbon-di-oxide Transport, Coupling of Oxygen & Carbon-di-oxide Exchange, Shear Induced Transport, Augmentation and Devices for Improved Gas Transport.

UNIT IV: ARTIFICIAL KIDNEY & ARTIFICIAL PANCREAS: NUMBER OF HOURS**9**

Artificial Kidney: Renal Transplantation, Mass Transfer in Dialysis, Membranes, Hemofiltration, Adequacy of Dialysis, Peritoneal Dialysis Equipment. Artificial pancreas: Insulin Therapy, Therapeutic options in Diabetes, Insulin Administration System, Insulin Production System.

UNIT V: ARTIFICIAL BLOOD & ARTIFICIAL LIVER**9**

Artificial Blood: Plasmapheresis, Blood Substitutes, Hemo dilution, Classification, Characterisation of Substitutes. Artificial Liver: Liver Support Systems, Global Liver Function Replacement, Hybrid Liver Function Replacement.

TOTAL: 45 HOURS**TEXT BOOKS**

1. 'Tissue Engineering and Artificial Organs' By Joseph D.Bronzino
2. 'Cardiogenic Shock' by Steven.M. Hollenberg.

REFERENCES

1. 'Biomaterials, Artificial Organs and Tissue Engineering' by Larry L.Hench and Julian R.Jones.
2. "Artificial Organs" by Gerald E.Miller Morgan & Claypool Publisher

OPEN ELECTIVES

Sl. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	BM32D5	Robotics in Healthcare	3	0	0	3
2	BM32D6	Medical Optics	3	0	0	3
3	BM32D7	Computers in Medicine	3	0	0	3
4	BM32D8	Medical Equipment's Manufacturing Guidelines and Policies	3	0	0	3
5	BM32D9	Intellectual Property Rights	3	0	0	3
7	BM32E1	Rehabilitation Engineering	3	0	0	3
8	BM32E2	Bio fluids and Dynamics	3	0	0	3
10	BM32E3	Hospital System Management	3	0	0	3

BM32D5	ROBOTICS IN HEALTHCARE	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge about the basics of Robotics.
- To provide knowledge on the application of robotics in the field of health care.
- To study the various applications of robot in the medical field.

Course Outcome		Cognitive Skill
CO-01	Understand the different types of medical robots and their potential applications.	U, R
CO-02	Know basic concepts in kinematics, dynamics, and control relevant to medical robotics.	U, An, R
CO-03	Understand to develop the analytical and experimental skills necessary to design.	U, E, S
CO-04	Implement robotic assistance for both minimally invasive surgery and image-guided interventions.	U, R, A
CO-05	Familiar with the state of the art in applied medical robotics and medical robotics research.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO \ CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	M	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	M	S	S	L	M	S	M	S	S
CO-04	S	M	M	M	M	S	M	L	M	M	S	M	M
CO-05	S	M	S	M	S	S	S	L	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: FUNDAMENTALS OF ROBOTICS

9

Introduction to Robotics – Robot manipulation - Kinematics – Robotic vision- Techniques for planning robot motions - mechanical design aspects - programming of robots.

UNIT II: SURGICAL ROBOTS

9

Minimally invasive surgery and robotic integration – surgical robotic sub systems - synergistic control. Control Modes Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

UNIT III: DESIGN OF MEDICAL ROBOTS

9

Types of medical robots - State of art of robotics in the field of healthcare- Characterization of gestures to the design of robots- Design methodologies- Technological choices- Security.

UNIT IV: ROBOTS IN REHABILITATION AND MEDICAL CARE

9

Rehabilitation for Limbs – Orthosis- Prosthesis- Brain-Machine Interfaces - Steerable Needles

– Assistive robots –types of assistive robots – Interactive therapy

UNIT V: RECENT TRENDS IN MEDICAL ROBOTS

9

Nano robots - Endoscopy Bot-Disinfectant Bots – Micro robot targeted therapy -Companion Robots-Clinical Training Robots-Robotic Nurses –Telepresence Robots - Artificial Intelligence (AI) Diagnostics and Epidemiology - case studies

TOTAL: 45 HOURS

TEXT BOOKS

1. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall, 2003.
2. Paula Gomes, "Medical robotics, minimally invasive surgery", Woodhead, 2012.

REFERENCE BOOKS

1. J.J.Craig, Introduction to Robotics, Pearson Education, 2005.
2. Achim Schweikard, Floris Ernst, —Medical Robotics, Springer, 2015.
3. Jocelyne Troccaz, —Medical Robotics, Wiley-ISTE, 2012.
4. Vanja Bonzovic, Medical Robotics, I-tech Education publishing, Austria, 2008.

BM32D6	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study in-depth the various optical properties of tissues and light interactions with tissues.
- To study about various optical sources and instrumentation for various measurements.
- To study various applications of lasers.
- To understand the special techniques like photo dynamic therapy and optical holography.

Course Outcome		Cognitive Skill
CO-01	Know the fundamentals of optical properties of tissues.	U, R
CO-02	Analyze the components of instrumentation in Medical Photonics and Configurations.	U, An, R
CO-03	Know the surgical applications of lasers.	U, E, S
CO-04	Describe photonics and its diagnostic applications.	U, R, A
CO-05	Investigate emerging techniques in medical optics.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	M	M	S	S	S	S	M	S	S
CO-02	S	M	S	S	L	S	S	M	M	S	S	L	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	S	S
CO-04	M	S	M	S	L	S	M	L	M	M	M	M	M
CO-05	S	M	S	S	S	S	S	L	S	M	M	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: OPTICAL PROPERTIES OF THE TISSUES**9**

Refraction, Scattering, absorption, light transport inside the tissue, tissue properties, Light interaction with tissues, optothermal interaction, fluorescence, speckles.

UNIT II: INSTRUMENTATION IN PHOTONICS**9**

Instrumentation for absorption, scattering and emission measurements, excitation light sources – high pressure arc lamp, LASERs, optical filters, polarisers, solid state detectors, time resolved and phase resolved detectors.

UNIT III: APPLICATIONS OF LASERS**9**

Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology.

UNIT IV: OPTICAL HOLOGRAPHY**9**

Wave fronts, Interference patterns, principle of hologram, optical hologram, applications.

UNIT V: SPECIAL TECHNIQUES**9**

Near field imaging of biological structures, in vitro clinical diagnostic, fluorescent spectroscopy, photodynamic therapy.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Tuan VoDirh, “Biomedical photonics – Handbook”, CRC Press, Boca Raton, 2003 (Unit I – III, V).
2. Leon Goldman, M.D., & R. James Rockwell, Jr., “Lasers in Medicine”, Gordon and Breach, Science Publishers Inc., New York, 1971 (Unit IV).

BM32D7	COMPUTERS IN MEDICINE	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the 8086 architecture, instruction sets and various units of PC-AT.
- Study the technique of data acquisition, storage, retrieval and transmission of bio information.
- To understand the application of computers in patient monitoring.
- To understand the application of computers in system modelling and pattern recognition, medical imaging and development of expert systems.

Course Outcome		Cognitive Skill
CO-01	Know the fundamentals of computer hardware PC-AT.	U, R
CO-02	Analyze the system design	U, An, R
CO-03	Know the use of computers in patient monitoring.	U, E, S
CO-04	Analyze the uses of computers in medical systems modelling.	U, R, A
CO-05	know the uses of computers in medical research	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	S	S	M	S	M	M	S	M	M	M
CO-03	S	M	S	M	S	S	S	L	S	S	M	S	S
CO-04	M	S	M	S	M	M	M	L	M	M	M	M	M
CO-05	S	S	S	S	S	S	S	L	S	M	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: OVERVIEW OF COMPUTER HARDWARE PC-AT

9

8086 architecture, system connections, Instruction set & programming, Microcontrollers, Motherboard and its logic, RS232-C and IEEE bus standards, CRT controllers, FDC, HDC and Post sequence, PC based video card, modems and networking.

UNIT II: SYSTEM DESIGN

9

Multichannel computerised ECG, EMG and EEG data acquisition, storage and retrieval, transmission of signal and images.

UNIT III: COMPUTERS IN PATIENT MONITORING

9

Physiological monitoring, automated ICU, computerised arrhythmia monitoring, information flow in a clinical lab, computerised concepts, interfacing to HIS.

UNIT IV: COMPUTERS IN MEDICAL SYSTEMS MODELLING

9

Radiotherapy, drug design, drug delivery system, physiological system modelling and simulation.

UNIT V: COMPUTERS IN MEDICAL RESEARCH

9

Role of expert systems, pattern recognition techniques in medical image classification, ANN concepts.

TOTAL: 45 HOURS

TEXT BOOKS

1. R.D.Lee, "Computers in Medicine", Tata McGraw-Hill, New Delhi, 1999.
2. Douglas V.Hall, "Microprocessors and Interfacing: Programming and hardware", McGraw-Hill, Singapore, 1999.

BM32D8	MEDICAL EQUIPMENT MANUFACTURING GUIDELINES AND POLICIES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know about the medical device guidelines and policies.
- To understand the regulations for medical devices in India and across the world.
- To understand various standards used in the health care.

Course Outcome		Cognitive Skill
CO-01	Understand the regulatory framework of medical device manufacture and marketing.	U, R
CO-02	Understand how statutory, manufacturers' and healthcare equipment.	U, An, R
CO-03	Know the rules provided requirements for import <i>and</i> manufacture the clinical devices.	U, E, S
CO-04	Understand an overview of international medical device regulations.	U, R, A
CO-05	Know the regulations and standards that apply in the clinical and medical device design and manufacturing environments.	E, U, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	S	M	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	S	S	M	L	S	M	M	S	S
CO-04	S	S	M	S	M	S	M	L	M	M	M	M	M
CO-05	S	S	S	M	S	S	S	L	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: MEDICAL DEVICES STANDARDS AND REGULATIONS

9

Medical Standards and Regulations – Device classification – Registration and listing Declaration of conformance to a recognized standard – Investigational Device Exemptions (IDEs) – Institutional Review Boards (IRBs) – IDE format – Good laboratory practices (GLPs) – Good manufacturing practices (GMPs) – Human factors – Design control

UNIT II: MEDICAL DEVICES DIRECTIVES

9

The Medical Devices Directives (MDD) – Definition, Process and choosing the appropriate directive – Active Implantable Medical Devices Directive (AIMDD) – In Vitro Diagnostic Medical Devices Directive (IVDMDD).

UNIT III: MEDICAL STANDARDS**9**

Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA – Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine – Bioethics NABH and NABL .

UNIT IV: PRODUCT DESIGN, TESTING AND QUALITY CONTROL**9**

Design specification, product development plan, Prototyping and testing, laboratory trials, clinical trials and human trials, premarket testing and validation, drug development and clinical trials, system testing, regulation and standards, manufacturing and quality control – design quality, reliability control, human and tissue interaction testing, electrical and electronic quality control, calibration and validation

UNIT V: MEDICAL DEVICE REGULATIONS**9**

Critical elements for regulatory attention, Stages of regulatory control, A common framework for medical device regulations, Regulatory tools and general requirements, Regulatory guidelines for medical devices in India, Regulatory guidelines for medical devices across the world.

TEXT BOOKS

1. Richard Fries, “Reliable Design of Medical Devices – Second Edition”, CRC Press, Taylor & Francis Group, 2006.
2. Physical Environment Online: A Guide to The Joint Commissions Safety Standards, HCPro, Inc. 2010

REFERENCE BOOKS

1. Joint Commission Accreditation Standards for Hospitals, 2nd edition 2003.
2. Medical Device Regulations Global Overview and Guiding Principles, World Health Organization 2003.
3. Regulatory guidelines for medical devices in India, by N Radhadevi - 2014

BM32D9	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Stimulate the creation and growth of intellectual property by undertaking relevant measures.
- Modernize and strengthen IP administration.
- Catalyze commercialization of IP rights.

Course Outcome		Cognitive Skill
CO-01	The students once they complete their academic projects.	U, R
CO-02	Know how to get awareness of acquiring the patent and copyright for their innovative works.	U, An, R
CO-03	Attain the awareness of acquiring the copyright for their innovative works.	U, E, S

CO-04	Preparation and processing of patent application	U, R, A
CO-05	Get the knowledge of plagiarism in their innovations which can be questioned legally.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	M	S	M	S	S	M	S	M	S	M	S	M	M
CO-03	S	M	S	M	M	S	S	L	S	S	M	S	S
CO-04	S	S	M	M	M	L	M	L	M	M	S	M	M
CO-05	S	M	S	M	S	S	S	L	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: INTRODUCTION TO IPR

9

Concept & Meaning of Intellectual Property - Origin and Development of IPR – Historical and theoretical basis for protection of IPR - Need for Protecting IP - Theories of IPR - Importance of Patent Information in Economic and Business Development

UNIT II: FORMS OF IPR

9

Introduction – Copyright – Trademark – Patents – Industrial Designs – Trade Secrets – Geographical Indications - Application of different forms of IPR.

UNIT III: PREPARATION AND PROCESSING OF PATENT APPLICATION

9

Preparation: Procedure for Filing of Patent Application and types of Applications - Lab Notebooks/Log Books/Record Books - Methods of Invention Disclosures - Patent Application and its Contents - Writing of the Patent Document. **Processing:** Publication of Patent Applications - Request for Examination - Process for Examination & Prosecution - Reissue & Reexamination

UNIT IV: INTERNATIONAL AND INDIAN IP REGIME

9

World Intellectual Property Organization (WIPO) – Functions of WIPO – Membership – GATT Agreement – Major Conventions on IP – Berne Convention – Paris Convention – TRIPS agreement. Overview of IP laws in India – Major IP Laws in India – International treaties signed by India, IPR and Constitution of India.

UNIT V: INTELLECTUAL PROPERTY FOR BIOENGINEERING

9

Overview of Bioengineering and IPR – Biomedical Research and IPR – Licensing and enforcing IPR – Case Studies in Bioengineering – Career opportunities in IPR.

TEXT BOOKS

1. Intellectual Property Rights and the Law, Dr. G.B. Reddy, Gogia Law Agency, 11th Edition 2016.
2. Law relating to Intellectual Property, Dr. B.L.Wadehra, Universal Law Publishing Co,2011.
3. IPR laws P. Narayanan, 1990.
4. Law of Intellectual Property, Dr.S.R. Myneni, Asian Law House, 2012.

REFERENCE BOOKS

1. Reddy G.B. Intellectual Property Rights and the Law, Gogia Law Agency, 2012

2. Singh K, Intellectual Property rights on Biotechnology, 2001.
3. <http://nptel.ac.in/courses/121106007/>
4. <http://nptel.ac.in/courses/107108011/>

BM32E1	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- Technological developments and their role in design of assistance devices.
- Sensory augmentation techniques in developing environmental control systems.
- Subjective and objective measurement in characterizing systems in task-situations.
- Role of BCI (Brain Computer Interface) in Rehabilitation.

Course Outcome		Cognitive Skill
CO-01	The student will know the basic concepts of rehabilitation	U, R
CO-02	Familiarization of orthotics and prosthetics devices	U,An, R
CO-03	Know the sensory augmentation and substitution	U, E,S
CO-04	Know the measurement tools and processes in rehabilitation engineering	U, R, A
CO-05	Know the uses of computers in Rehabilitation Engineering	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	M	S	S	S
CO-02	S	M	S	S	M	M	S	M	M	M	S	M	S
CO-03	S	M	S	S	M	S	S	L	M	S	S	S	S
CO-04	S	M	S	M	S	S	M	L	M	M	S	S	M
CO-05	S	M	S	M	S	S	M	L	S	M	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I: REHABILITATION CONCEPTS

9

Engineering Concepts in Sensory Rehabilitation; Engineering Concepts in Motor Rehabilitation: Engineering Concepts in Communication Disorders Orthopedic prosthetics and orthotics in Rehabilitation: Basics and Fundamentals in rehabilitation and its applications. Knowledge of disability act 1995 for physically disabled, visually impaired, hearing impaired and others

UNIT II: ORTHOTICS AND PROSTHETICS DEVICES

9

Intelligent prosthetic knee. A hierarchically controlled prosthetic hand. A self-aligning orthotic knee joint. FES systems: Restoration of hand function: Hybrid Assistive Systems (HAS). Active prosthesis: Active Above Knee Prostheses. Myoelectric hand and arm prostheses.. Wheeled Mobility: Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair propulsion. Power Wheelchair Electrical Systems. M Control. Personal Transportation.

UNIT III: SENSORY AUGMENTATION AND SUBSTITUTION**9**

Visual system: Visual augmentation. Tactual vision substitution. Auditory vision substitution: Auditory system: Auditory augmentation. Cochlear implantation. Visual auditory substitution. Tactual auditory substitution. Tactual system: Tactual augmentation. Tactual substitution.. Augmentative communication; Environmental Control systems and Robotic manipulation aids; Environmental Control and Access to computers.

UNIT IV: MEASUREMENT TOOLS AND PROCESSES IN REHABILITATION ENGINEERING**9**

Fundamental Principles: Structure function: Performance and Behaviour. Subjective and Objectives measurement methods. Measurements and assessments; measurement Objectives and Approaches;. Decision Making Process; Current Limitations: Quality of measurements, standards. Rehabilitation service delivery and Rehabilitation Engineering.

UNIT V: COMPUTER APPLICATIONS IN REHABILITATION ENGINEERING**9**

Interfaces in Compensation for visual perception. Improvement of orientation and mobility. Computer assisted lip reading. Brain-computer interfaces. Computer-Aided Engineering in customized component design.

TOTAL: 45 HOURS**TEXT BOOKS**

1. Robinson C.J. Rehabilitation Engineering, CRC Press. 1995
2. Ballabio E...Rehabilitation Technology. IOS Press. 1993

BM32E2	BIO-FLUID AND DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To classify the fluids according to its characteristics.
- To study the pressure and flow patterns in blood vessels.
- To use this knowledge in studying the mechanics available at cardiac system.

Course Outcome		Cognitive Skill
CO-01	Identify and evaluate fluids according to its characteristics.	U, R
CO-02	Understand basic Different types of fluid flows.	U,An, R
CO-03	Formulate a boundary layer flow	U, E,S
CO-04	Understand the pressure and flow in blood vessels	U, R, A
CO-05	Analayze Cardio Vascular Dynamics	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	M	S	M	S	S	S	L	S	S	S	S	S
CO-02	M	S	M	S	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	S	S	S	S	S	L	M	S	S
CO-04	S	M	M	M	M	S	S	M	M	M	S	L	M
CO-05	S	S	S	M	S	S	S	L	S	S	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

9

Fluids and non-fluids, continuum coordinate systems, force and moments, stress at a point, rate of strain, properties of fluids, classification of fluids.

9

Different types of fluid flows, laminar and turbulent flow, transition from laminar to turbulent flow, laminar flow-annulus, laminar flow between parallel plates, measurement of viscosity.

9

Development of boundary layer, estimates of boundary layer thickness, boundary layer equation, nature of turbulence, smooth and rough surface, boundary layer separation.

9

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.

9

Control theory and system analysis, mechanical analysis of circulatory systems, basic concept of myocardial mechanics, index of contractibility, fluid dynamics of aortic and mitral valves.

TOTAL: 45

TEXT BOOKS

1. K.L.Kumar, "Engineering fluid mechanics", Eurasia Publishing House (P) Ltd., NewDelhi, 1998.
2. D.H.Bergel, "Cardiovascular fluid dynamics"- Vol. I, Academic press, London & NewYork, 1972.

BM32E3	HOSPITAL SYSTEM MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To define the need and role to be performed by biomedical technical personnel in the hospital.
- To understand the management in healthcare and the importance of hospital management.
- To understand various standards used in the health care.
- To understand safety procedures followed in hospitals.

Course Outcome		Cognitive Skill
CO-01	Critically analyze the various components of health care delivery system in India.	U, R
CO-02	Understand and learn public health care system in India.	U,An, R
CO-03	Apply various principles of planning and management in implementing health projects and programme	U, E,S

CO-04	Understand and familiarize the details of the quality requirements for medical gases	U, R, A
CO-05	Recognize the various sections of healthcare legislations in India and initiate appropriate actions in public health practice.	E, U,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	L	M	S	M	S	L	S	S	S	S	S
CO-02	S	S	M	S	S	M	S	M	M	M	S	M	M
CO-03	S	M	S	M	M	S	S	L	S	S	M	S	S
CO-04	S	S	M	M	M	S	M	L	M	M	S	M	M
CO-05	S	S	S	M	S	S	S	L	S	M	M	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I : INTRODUCTION TO PUBLIC HEALTH

9

Evolution of Public Health, Important Public Health Acts, Health problems of developed and developing countries, Health problems in India, Environment and Health, Health planning in India including various committees and National Health Policy and Health Goals set from time to time.

UNIT II: HEALTH SYSTEMS IN INDIA

9

Organized sector with reference to Centre, State, District and Block level structures and local bodies and Panchayati Raj Organization and functions of community health Centre's and Primary Health Centres (PHCs), Referral Hospitals, General Hospitals and Medical College. Health Manpower, Primary Health care and concept, Alternative systems of medicine, like Ayurveda, Homeopathy, etc. Holistic Approach Non -Governmental Organizations (NGOs) and Private Voluntary Organisations (PVOs). Unorganized Sector.

UNIT III : HOSPITAL OPERATION MANAGEMENT

9

Principles of Hospital Management, Strategic management of Hospitals, Organizational structure and behavior, financial management, Human resource management, Purchase-logistics-inventory management, market analysis and operational research, epidemiology and health systems.

UNIT IV: HOSPITAL SUPPORT SERVICES

9

Introduction to concept of central medical gas supply system, basic components, manifold, suction apparatus – parts, working and uses, introduction to pendant for gas supply, safety and precautions in manifold and pipeline supply. Introduction to clean room concepts, clean room air conditioning, zoning in hospitals. Introduction to electrical standards and specific electrical requirements in hospitals.

UNIT V: PATIENT SAFETY

9

Importance of general safety in hospitals, the effects of electricity on human body, electric shock hazards and precautions to avoid shock, IEC document and safety codes of biomedical equipment, grounding in Biomedical Equipment, familiarize Rules and Ethics in medical field. Biomedical equipment cleaning and disinfection, bioelectrical safety and hazard management.

TOTAL: 45 HOURS

TEXT BOOKS

1. Girdhar J Gyani and Alexander Thomas, Handbook of Healthcare Quality & Patient Safety, Second Edition, 2016.
2. James R. Langabeer II and Jeffrey Helton, Health Care Operations Management: A Systems Perspective, Second Edition, 2015.
3. DH Estates and Facilities Directorate, Medical gases Health Technical Memorandum 02-01: Medical gas pipeline systems, 2006

REFERENCE BOOKS

1. Jason Di Marco, Handbook Medical Gas Systems, Third Edition, 2017
2. National Disaster Management Authority Government of India, Handbook National Disaster Management Guidelines—Hospital Safety, 2016
3. Dr. Shalini Suri, Hospital Management and Hospital Operations, 2016.