Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

B.E. Biomedical Instrumentation Engineering
(Syllabus for Students Admitted during 2024-2025)

School of Engineering
Approved by AICTE
Ayya Avinashilingam Nagar, Chinna Thadagam Post,
Coimbatore - 641 108
Website: http://www.avinuty.ac.in * Email: hod_bmie@avinuty.ac.in
University Campus – Ph:0422-2440241/2435550
Campus II – Ph : 0422-2658145/2658716

Avinashilingam Institute for Home Science and Higher Education for Women

(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with 'A++' Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

School of Engineering

B.E. Biomedical Instrumentation Engineering

Programme Specific Outcomes:

PSO1: Create engineers who can work in the field of Image Processing, Sensors & Actuators, Biomedical Instruments, Communication, MEMS and allied fields to develop innovative Biomedical systems for the public wellness and safety.

PSO2: Develop skills for design, maintenance and testing of medical equipment.

Scheme of Instruction & Examination

(For students admitted from the academic year **2024-2025** and onwards)

Part	*Course Code*	*Name of the Course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
First Semester									
Induction Program including Universal Human Values (Introduction)									
I		**Humanities and Social Sciences (HS)**							
	24BEHS01	English for Technical Writing	2	0/2	3	50	50	100	3
II		**Basic Sciences (BS)**							
	24BESM01	Mathematics - I (Algebra and Calculus)	3	1/0	3	50	50	100	4
	24BESP02	Physics - Oscillation, Waves and Optics	3	0/2	3	50	50	100	4
III		**Core Courses** **Engineering Sciences (ES)**							
	24BEES01	Basic Electrical and Electronics Engineering	3	0/2	3	50	50	100	4
	24BEES02	Programming for Problem Solving using C (CSE)	3	-	3	50	50	100	3
	24BEES05	Programming for Problem Solving using C Laboratory (CSE)	-	0/2	3	50	50	100	1
	24BEES06	Engineering Practices Laboratory	-	0/4	3	50	50	100	2
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC01	Environmental Science	3	-	2	100	-	100	Remark
	24EVBNS1/ 24EVBNC1/ 24EVBSP1	Value Based Elective I NSS-I/NCC-I/Sports-I	-	-	2	100	-	100	Remark
Second Semester									
I		**Humanities and Social Sciences (HS)**							
	24BEHS02	Universal Human Values -II (Understanding Harmony and Ethical Human Conduct)	2	1/0	3	50	50	100	3
II		**Basic Sciences (BS)**							
	24BESM02	Mathematics-II (Laplace Transforms and Complex Variables)	3	1/0	3	50	50	100	4
	24BESC01	Applied Chemistry	3	0/2	3	50	50	100	4
III		**Core Courses** **Engineering Sciences (ES)**							
	24BEES08	Computer Aided Engineering Graphics (CIVIL)	2	0/3	3	50	50	100	3
	24BEES09	Programming for Problem Solving using Python (CSE)	3	-	3	50	50	100	3
	24BEES10	Electric Circuit Analysis	3	-	3	50	50	100	3
	24BEES13	Programming for Problem Solving using Python Laboratory (CSE)	-	0/2	3	50	50	100	1
	24BEES14	Electric Circuit Analysis Laboratory	-	0/2	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC02	Constitution of India	2	-	2	100	-	100	Remark
	24EVBNS2/ 24EVBNC2/ 24EVBSP2	Value Based Elective-I NSS-II/NCC-II/Sports-II	-	-	2	100	-	100	Remark

Part	*Course Code*	*Name of the course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
Third Semester									
II		**Basic Sciences (BS)**							
	24BESM04	Mathematics-III (Transforms, Partial Differential Equations and Applications)	3	1	3	50	50	100	4
III		**Core Courses Engineering Sciences (ES)**							
	24BEES17	Electronic Devices and Circuits	3	-	3	50	50	100	3
	24BEES18	Electronic Devices and Circuits Laboratory	-	0/3	3	50	50	100	1
		Core Courses Professional Core (PC)							
	24BEBC01	Human Anatomy and Physiology	3	-	3	50	50	100	3
	24BEBC02	Medical Biochemistry	3	-	3	50	50	100	3
	24BEBC03	Biomaterials	3	-	3	50	50	100	3
	24BEBC04	Biomedical Sensors and Measurement Devices	3	-	3	50	50	100	3
	24BEBC05	Biomedical Sensors and Measurement Laboratory	-	0/3	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC03	Consumer Affairs	3	-	2	100	-	100	Remark
	24BEBV01	Value Added Course – PCB Design	2	-	2	100	-	100	Remark
Fourth Semester									
I		**Humanities and Social Sciences (HS)**							
	24BEHS03	Biomedical Waste Management	3	-	3	50	50	100	3
II		**Core Courses Engineering Sciences (ES)**							
	24BEES24	Numerical Techniques	3	-	3	50	50	100	3
III		**Core Courses Professional Core (PC)**							
	24BEBC06	Pathology and Microbiology	3	-	3	50	50	100	3
	24BEBC07	Signal Processing	3	1/0	3	50	50	100	4
	24BEBC08	Control Systems	3	1/0	3	50	50	100	4
	24BEBC09	Analog and Digital Integrated Circuits	3	-	3	50	50	100	3
	24BEBC10	Integrated Circuits Laboratory	-	0/3	3	50	50	100	1
	24BEBC11	Signal Processing Laboratory	-	0/3	3	50	50	100	1
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC04	Essence of Indian Knowledge Tradition	3	-	2	100	-	100	Remark
	24BECS01	Communication Skills	3	-	2	100	-	100	Remark
		# 6 to 8 weeks Industrial Internship during summer vacation							

Part	*Course Code*	*Name of the Course/ component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
Fifth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BEBC12	Analog and Digital Communication	3	-	3	50	50	100	3
	24BEBC13	Medical Diagnostic Equipment	3	-	3	50	50	100	3
	24BEBC14	Medical Therapeutic Equipment	3	-	3	50	50	100	3
	24BEBC15	Biomechanics	3	-	3	50	50	100	3
	24BEBC16	Microprocessors and Microcontrollers	3	-	3	50	50	100	3
	24BEBC17	Diagnostic and Therapeutic Equipment Laboratory	-	0/3	3	50	50	100	1
	24BEBC18	Microprocessors and Microcontrollers Laboratory	-	0/3	3	50	50	100	1
		Professional Elective (PE)							
		Professional Elective – I (PE1 or PE2)	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC05	Design Thinking	1	0/2	2	100	-	100	Remark
	24BESS01	Soft Skills	3	-	2	100	-	100	Remark
Professional Elective-I (Select one course either from PE1 or PE2)									
PE1: 24BEBE01 Human Assist Devices/ 24BEBE02 Medical Optics/ 24BEBE03 Brain Computer Interface/ 24BEBE04 Rehabilitation Engineering			**PE2:** 24BEBE21 Speech Processing / 24BEBE22 Biostatistics/ 24BEBE23 Biometric Systems/ 24BEBE24 Biosignal Processing						
Sixth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BEBC19	Radiology and Nuclear Medicine	3	-	3	50	50	100	3
	24BEBC20	ICU and Operation Theatre Equipment	3	-	3	50	50	100	3
	24BEBC21	Embedded Systems and IoMT	3	-	3	50	50	100	3
	24BEBC22	Digital Image Processing	3	-	3	50	50	100	3
	24BEBC23	Virtual Instrumentation Laboratory	-	0/3	3	50	50	100	1
	24BEBC24	Digital Image Processing Laboratory	-	0/3	3	50	50	100	1
	24BEBC25	Mini Project	-	0/4	-	100	-	100	2
		Professional Electives (PE)							
		Professional Elective – II (PE1 or PE2)	3	-	3	50	50	100	3
	24BEBE40 - 24BEBE59	Professional Elective – III (PE1 or PE2) Title of MOOC (SWAYAM-NPTEL) ##	3	-	-	-	100	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC06	Professional Ethics	3	-	2	100	-	100	Remark
	24BVBAP1/ 24BVBGP1/ 24BVBWS1/ 24BSCGA1/ 24BSCQA1	Value Based Elective-II	-	-	2	100	-	100	Remark
# 6 to 8 weeks Industrial Internship during summer vacation									
Professional Elective-II (Select one course from PE1 if the student selected PE1 in 5th semester or select one course from PE2 if the student selected PE2 in 5th semester)									
PE1: 24BEBE05 Medical Device Regulations/ 24BEBE06 Artificial Organs and Implants/ 24BEBE07 BioMEMS and Nanotechnology/ 24BEBE08 Electromagnetic Interference and Compatibility			**PE2:** 24BEBE25 Medical Informatics/ 24BEBE26 Artificial Intelligence and Machine Learning / 24BEBE27 Body Area Networks/ 24BEBE28 Medical Data Analytics						
Professional Elective-III **## One MOOC (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 3 credits, as an alternative to Professional Elective - III in VI Semester which should be completed between 3rd and 7th semester. Title of the MOOC to be specified after enrollment.**									

Part	*Course Code*	*Name of the Course/component*	*Hours of Instruction/week*		*Scheme of Examination*				
			Theory	*Tutorial/ Practical*	*Duration of exam*	*CIA*	*CE*	*Total*	*Credit*
Seventh Semester									
I		**Humanities and Social Sciences (HS)**							
	24BEHS07	Hospital Management	3	-	3	50	50	100	3
III		**Core Courses** **Professional Core (PC)**							
	24BEBC26	Medical Imaging Techniques	3	-	3	50	50	100	3
	24BEBC27	Hospital Internship	-	0/4	3	50	50	100	2
	24BEBC28	Industrial Internship[#]	-	-	3	100	-	100	2
	24BEBC29	Project Work - Phase I	-	0/4	-	100	-	100	2
		Professional Electives (PE)							
		Professional Elective – IV (PE1 or PE2)	3	-	3	50	50	100	3
	24BEBE60- 24BEBE79	Professional Elective – V (PE1 or PE2) Title of MOOC (SWAYAM-NPTEL)[##]	3	-	-	-	100	100	3
		Open Electives (OE)							
	24BEVO01/ 24BEOO01/ 24BELO01/ 24BEFO01/	Open Elective -1	3	-	3	50	50	100	3
IV		**Non-Credit Mandatory Courses (NCMC)**							
	24BEMC07	Disaster Management	3	-	2	100	-	100	Remark
	24BEMB01	Biomedical Instrumentation Engineering - Computer Based Test (CBT)	-	-	2	100	-	100	Remark

Professional Elective-IV (Select one course from PE1 if the student selected PE1 in 5th & 6th semesters or select one course from PE2 if the student selected PE2 in 5th & 6th semesters)

PE1:	**PE2:**
24BEBE09 Patient Safety, Standards and Ethics / 24BEBE10 Cell and Tissue Engineering/ 24BEBE11 Modeling of Physiological Systems/ 24BEBE12 Wearable Systems	24BEBE29 Telemedicine / 24BEBE30 Bio-Inspired Optimization Techniques / 24BEBE31 Robotics and Automation in Medicine / 24BEBE32 Computer Vision

Professional Elective-V

[##] One MOOC (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 3 credits, as an alternative to Professional Elective - V in VII Semester which should be completed between 3rd and 7th semester. Title of the MOOC to be specified after enrollment.

Open Elective - I

24BEVO01 Vaastu Shastra and Remedial Vaastu/
24BEOO01 Open Source for Everyone/
24BELO01 Sensors/
24BEFO01 Fundamentals of Food Process Engineering/
24BEPO01 3D Printing Techniques

Eighth Semester									
III		**Core Courses** **Professional Core (PC)**							
	24BEBC30	Project Work - Phase II	-	0/20	-	100	100	200	10
		Open Electives (OE)							
	24BEVO02/ 24BEOO02/ 24BELO02/ 24BEFO02	Open Elective - II	3	-	3	50	50	100	3
	24BEVO03/ 24BEOO03/ 24BELO03/ 24BEFO03	Open Elective - III	3	-	3	50	50	100	3

Open Elective - II	**Open Elective-III**
24BEVO02 Real Estate Practices/ 24BEOO02 Cyber Laws and Security Policies/ 24BELO02 Drone Technologies/ 24BEFO02 Principles of Nutrition/ 24BEPO02 Cross Media Publishing Techniques	24BEVO03 Green Building Concepts/ 24BEOO03 Introduction to Data Analytics/ 24BELO03 IoT in Connected Cars/ 24BEFO03 Food Preservation Technology/ 24BEPO03 Multimedia Development

Total Credits	**165**

Semester	*Course Code*	*Name of the Course/component*	*Hours of Instruction/ week / Course*	*Credit/ Course*
Part – IV Non-Credit Mandatory Courses (NCMC)				
	A. Ability Enhancement Compulsory Courses (AECC)			
1	24BEMC01	Environmental Science	3	Remark
2	24BEMC02	Constitution of India	2	
3	24BEMC03	Consumer Affairs	3	
4	24BEMC04	Essence of Indian Knowledge Tradition	3	
4	24BECS01	Communication Skills	3	
5	24BEMC05	Design Thinking	3	
5	24BESS01	Soft Skills	3	
6	24BEMC06	Professional Ethics	3	
7	24BEMC07	Disaster Management	3	
	B. Skill Enhancement Courses (SEC)			
3	24BEBV01	**Value Added Course** PCB Design	40 hrs. duration	Remark
	C. Value Based Elective- I			
1-2	24BVBNS 1-2/ 24BVBNC 1-2/ 24BVBSP 1-2	NSS I & II / NCC I & II / Sports I & II (Representing the Institute)	-	Remark
	Value Based Elective-II			
6	24BVBAP1/ 24BVBGP1/ 24BVBWS1/ 24BSCGA1/ 24BSCQA1	Principles of Dr. Ambedkar's Philosophy/ Gandhian Philosophy/ Women Empowerment Perspective in the Current Scenario/ General Awareness/ Quantitative Aptitude	Varied duration	Remark
	D. Computer Based Test (CBT)			
7	24BEMB01	Biomedical Instrumentation Engineering	-	Remark

Minimum credits required to earn the B.E. degree: 165

Requirements to earn the B.E. degree:

1. Total credits to be earned in Part I, II & III components: 165
2. Successful completion of Part IV Non–Credit Mandatory Courses (NCMC).
3. Minimum of two 3 credit (12 weeks duration) MOOCs to be completed through SWAYAM–NPTEL as an alternative to two Professional Electives, Elective III & Elective V (##with credit transfer)
4. #6 to 8 weeks Industrial Internship during 4th and /or 6th semester during summer vacation.

List of Professional Electives (PE1) Bio Instrumentation domain

Part	*Semester*	*Course Code*	*Name of the Course/component*
III	**V *Semester* Professional Elective I**	24BEBE01	Human Assist Devices
		24BEBE02	Medical Optics
		24BEBE03	Brain Computer Interface
		24BEBE04	Rehabilitation Engineering
	VI *Semester* Professional Elective II	24BEBE05	Medical Device Regulations
		24BEBE06	Artificial Organs and Implants
		24BEBE07	BioMEMS and Nanotechnology
		24BEBE08	Electromagnetic Interference and Compatibility
	VI *Semester* Professional Elective III	24BEBE40/ 24BEBE41/ - 24BEBE49	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
	VII *Semester* Professional Elective IV	24BEBE09	Patient Safety, Standards and Ethics
		24BEBE10	Cell and Tissue Engineering
		24BEBE11	Modeling of Physiological Systems
		24BEBE12	Wearable Systems
	VII *Semester* Professional Elective V	24BEBE60/ 24BEBE61/ - 24BEBE69	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**

List of Professional Electives (PE2) Biomedical Computing & Communication domain

Part	*Semester*	*Course Code*	*Name of the Course/component*
III	**V *Semester* Professional Elective I**	24BEBE21	Speech Processing
		24BEBE22	Biostatistics
		24BEBE23	Biometric Systems
		24BEBE24	Biosignal Processing
	VI *Semester* Professional Elective II	24BEBE25	Medical Informatics
		24BEBE26	Artificial Intelligence and Machine Learning
		24BEBE27	Body Area Networks
		24BEBE28	Medical Data Analytics
	VI *Semester* Professional Elective III	24BEBE50/ 24BEBE51/ - 24BEBE59	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
	VII *Semester* Professional Elective IV	24BEBE29	Telemedicine
		24BEBE30	Bio-Inspired Optimization Techniques
		24BEBE31	Robotics and Automation in Medicine
		24BEBE32	Computer Vision
	VII *Semester* Professional Elective V	24BEBE70/ 24BEBE71/ - 24BEBE79	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**

Open Electives offered by the Department

Part	*Semester*	*Course code*	*Name of the course/Component*
III	VII	24BEBO01	IoT for Personal Healthcare
	VIII	24BEBO02	Telehealth Technology
	VIII	24BEBO03	Diagnostic Instrumentation

Remark for NCMC Courses

Range of Marks	*Remark*
90-100	Excellent
75-89	Very Good
60-74	Good
40-59	Fair
Less than 40	Not Completed

B.E. Honours (AI in Healthcare) (OPTIONAL)

Part	*Semester*	*Course Code*	*Name of the Course/Component*
III	**V S*emester***	24BEBH01	IoT in Healthcare
		24BEBH02	Predictive Analytics in Healthcare
	VI S*emester*	24BEBH03	Virtual Reality and Augmented Reality in Healthcare
		24BEBH04	AI in Healthcare
	To be completed between 5th to 7th semesters	24BEBH51/ 24BEBH52/ - 24BEBH60	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BEBH61/ 24BEBH62/ - 24BEBH70	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**

Minor Specialization (Bioinstrumentation) (OPTIONAL)

Part	*Semester*	*Course Code*	*Name of the Course/Component*
III	**V S*emester***	24BEBE01	Human Assist Devices
		24BEBE04	Rehabilitation Engineering
	VI S*emester*	24BEBE06	Artificial Organs and Implants
		24BEBE10	Patient Safety, Standards and Ethics
	To be completed between 5th to 7th semesters	24BEBM01/ 24BEBM02/ - 24BEBM10	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**
		24BEBM11/ 24BEBM12/ - 24BEBM20	**MOOC (12 Weeks Course in SWAYAM – NPTEL)**

English for Technical Writing

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of instruction/week: 2T+2P**

24BEHS01 **No. of credits: 3**

Course Learning Objectives:

CLO1: Comprehension of spoken and written deliberations

CLO2: Presentation in academic and professional situations

CLO3: Employability skills needed for job interviews and placement

Unit I Introduction to Technical writing 6

Technical Vocabulary/ Jargon, Word formation, Impersonal passive voice, Tenses, use of prepositions, 'if clauses', subject verb agreement, Editing, British and American English.

Unit II Internal & External Communications 6

Writing instructions and recommendations, Data interpretation, Paragraph writing, Formal letters-writing to officials (seeking permission for practical training, asking for Certificates, testimonials, calling for quotation, purchase letter, complaint letter) & Resume writing, Report Writing, E-mail writing, Framing Agendas, Minutes of the meeting.

Unit III Creative Writing 6

Designing an Advertisement, Interpreting advertisements, Slogan/caption writing, creating one's own advertisement for a product, writing blog and on social media platforms, apply best practices of technical writing to assessing new communications contexts and describing the ethical and safety issues regarding communication and the Internet.

Unit IV Speaking Skills 6

Group Discussion - GD strategies, initiating a discussion, persuasion skills, body language, ways of interrupting (non–offending), summarizing and concluding. Self-introduction, Interview skills & Mock interview.

Unit V Presentation Skills 6

Business and technical presentation, writing summary after reading articles from journals – Format for journal, articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references)

Total Hours: 30

List of Experiments:

1. Vocabulary enrichment – Word Formation
2. Justifying and Summarizing Skills – GRE, TOTEL &IELTS
3. Composing E-mails
4. Designing an advertisement
5. Self-Introduction
6. Group discussion
7. Mock Interview
8. Technical Presentation
9. Book Review
10. Public Speaking Skills

Total Hours: 30

References:

1. ***Bhushun Kumar Kul (2022)***. ***English for Technical Professionals with lab manual,*** Khanna Books Publishing Co (P) Ltd.
2. ***Hamlin Annemarie & Rubio Chris (2016).*** Central Oregon Community College, **Technical Writing**: Open Oregon Educational Resources: ISBN 13: 9781636350653 (Creative Commons Attribution Non Commercial Share Alike)
3. ***S.Sumant (2017). English for Engineers***. Tata Mcgraw Hill Education Private Limited: ISBN13: 978-8182091399.
4. ***Cindy*** **Leaney** ***(2007). Dictionary Activities***. Cambridge University Press.
5. ***Shreesh Chaudhary (2007) Better Spoken English***. Vikas Publishing House Pvt Ltd.

Course Outcomes:

At the end of the course, students will be able to:

CO 1: Construct organized academic and professional writing.

CO 2: Achieve proficiency in the effective use of language in various authentic career, related situations.

CO 3: Communicate effectively in different situations by using specific, technical vocabulary.

CO 4: Speak convincingly, express their opinions clearly, initiate a discussion, negotiate and argue using appropriate communicative strategies.

CO 5: Employ skills to face interviews and technical presentation skills.

CO-PO MAPPING

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

Mathematics – I (Algebra and Calculus)

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction/week: 3T+1Tu**
24BESM01 **No. of Credits: 4**

Course Learning Objectives:

CLO1: Develop skills in processing matrices and applications of differential calculus
CLO2: Enrich knowledge in solving problems in multiple integrals and ordinary Differential equations

Unit I Matrices **12**

Rank of a matrix – Consistency of a system of linear equations – Solution of a system of linear equations - Characteristic equation of matrix - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors - Cayley Hamilton theorem

Unit II Orthogonal Matrices **9**

Orthogonal matrices – Orthogonal transformation of a symmetric matrix - Reduction of quadratic form to canonical form by orthogonal transformation.

Unit III Functions of Several Variables **12**

Total derivative – Taylor's series expansion - Maxima and minima - Constrained maxima and minima by Lagrangian multiplier - Jacobians.

Unit IV Multiple Integrals **12**

Double integration – Cartesian and polar coordinates –Change of order of integration – Area as a double integral - Triple integration in cartesian coordinates and spherical polar coordinates - Volume as a triple integral.

Unit V Ordinary Differential Equations **15**

Linear equations of second order with constant coefficients and variable coefficients (Homogeneous equations of Euler type) - Method of variation of parameters - Simultaneous first order linear equations with constant coefficients.

Total hours : 60

References:

1. ***T.Veerarajan (*2016*), Engineering Mathematics (for semester I and II),*** updated 2nd Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. ***P.Kandaswamy, K.Thilagavathy and K.Gunavathy(2014), Engineering Mathematics, Volume I***, 10th Revised Edition, S. Chand & Co, New Delhi.
3. ***E.Kreyszig (2014), Advanced Engineering Mathematics***, 8th Edition, John Wiley and Sons (Asia) Ltd, Singapore.
4. ***Dennis G.Zill and MichaelR.Cullen(2012),Advanced Engineering Mathematics,***2nd edition, CBS Publishers.

5. ***Srimanta Pal and Subhodh C Bhunia (2012), Engineering Mathematics,*** 9th Edition, John Wiley and Sons.
6. ***Dr.B.S.Grewal(2014),Higher Engineering Mathematics***,43rdEdition,Khanna Publishers, New Delhi.
7. ***G.B.Thomas (2009), Calculus*** **,**11thEdition, Pearson Education.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Apply the concepts of matrices to solve problems in engineering.
CO2: Apply orthogonal transformation to reduce quadratic form of a matrix to canonical form.
CO3: Evaluate maxima and minima of a multivariable function.
CO4: Determine area and volume using multiple integrals.
CO5: Solve higher order linear ordinary differential equations.

CO-PO MAPPING

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

Physics - Oscillation, Waves and Optics

(Common to Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/Electronics and Communication Engineering)

Semester I **Hours of Instruction/week: 3T+ 2P**
24BESP02 **No. of credits: 4**

Course Learning Objectives:

CLO1: To impart knowledge in basic concepts of physics relevant to engineering and technology.

CLO2: To understand and apply the concepts of physics for various engineering applications.

CLO3: To impart experimental skills on potentially important experiments needed for Engineering.

Unit I Wave Mechanics **9**

Matter waves, De-Broglie's concept of matter waves, Properties of matter waves, Heisenberg's uncertainty principle, Schrödinger's time dependent and time independent equations, Schrödinger wave equation, Particle in one dimensional box, Electron microscope, Scanning electron microscope (SEM).

Unit II Ultrasonic Waves and Acoustics **9**

Introduction, Magnetostriction effect, Production of ultrasonic waves: Magnetostriction generator, Inverse piezoelectric effect, Piezoelectric generator, Properties, Ultrasonic Doppler Blood flow meter. Classification of sound, Weber- Fechner law, Absorption coefficient and its determination, Factors affecting acoustics of building and their remedies.

Unit III Optical Properties of Materials **9**

Photoconductive materials, Light Dependent Resistor, Working of LDR, Applications of LDR, Photovoltaic materials, Solar cell, Construction and working of a solar cell, Applications of solar cells, Liquid crystals, Liquid crystal Display(LCD), Construction and advantages of LCD.

Unit IV Lasers and Fiber optics **9**

Principle of spontaneous and stimulated emission, Einstein theory of stimulated emission, Population inversion, Pumping mechanism, Semiconductor laser, Application: holography. Fiber optics – Principle, Classification based on materials, refractive index profile, Applications: Fiber optic communication, Temperature sensor and Endoscope.

Unit V Waves and Oscillations **9**

Mechanical and electrical simple harmonic oscillators; damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator.

Total Hours: 45

List of Experiments (Any 10)

1. LASER- Wavelength & Particle size determination
2. Ultrasonic interferometer-Determination of compressibility of a liquid
3. Melde's apparatus- Frequency of the vibrator
4. Spectrometer- wavelength determination –Grating (Simulation Experiment).
5. Torsional Pendulum-Rigidity modulus of wire and Moment of inertia of disc.
6. Non Uniform bending – Determination of Young's Modulus.
7. LCR Bridge –Dielectric constant of Solids
8. Four Probe Apparatus-Band gap of a Semiconductor
9. Hysteresis curve tracer - Coercivity and Retentivity
10. Solar cell-V-I characteristics
11. Spectrometer- Determination of dispersive power of the prism.
12. Fiber optics – Numerical aperture

Total Hours: 30

References:

1. ***M.N.Avadhanulu, P.G.Kshirsagar, TVS Arun Murthy (2022). A Text Book of Engineering Physics***. S Chand Publications, New Delhi.
2. ***H.K.Malik, A.K.Singh (2021).Engineering Physics.*** McGraw Hill Education Private Limited, New Delhi.
3. ***D.R.Joshi (2010). Engineering Physics.*** McGraw Hill Education Private Limited, New Delhi.
4. ***S.O.Pillai (2014). A Textbook of Engineering Physics.*** New Age International (P) Limited, New Delhi.
5. ***B. B. Laud (2015). Lasers and Non-Linear Optics.*** New Age International Publications, New Delhi.
6. ***H.J. Pain (2013). The Physics of Vibrations and Waves.*** John Wiley and Sons.
7. ***Bhattacharya D.K and T.Poonam (2015). Engineering Physics***, Oxford University Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the importance of Wave Mechanics

CO2: Acquire the basic knowledge in Ultrasonics and Acoustics

CO3: Understand the principles of optical materials and devices for various engineering applications.

CO4: Understand the Principle and Applications of Lasers and Optical Fibers.

CO5: Identify the basic concepts of waves and oscillations in Engineering.

CO-PO MAPPING

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

Basic Electrical and Electronics Engineering

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction/week: 3T+2P**
24BEES01 **No. of credits: 4**

Course Learning Objectives:

CLO1: To impart knowledge in the basics of electrical circuits and working principles of electrical machines.

CLO2: To educate on the fundamental concepts of analog electronics, digital electronics and measuring instruments.

Unit I Electrical Circuits **9**

Circuit Components: Surface Mount Device (SMD) Components – Ohm's Law - Kirchhoff's Laws - Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state). Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power, apparent power and power factor.

Unit II Electrical Machines **9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Synchronous motor and Three Phase Induction Motor.

Unit III Basic Electronics **9**

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics- Introduction to BJT and JFET (Construction, working and characteristics).

Unit IV Digital Electronics **9**

Review of number systems, binary codes (BCD, ASCII), Logic gates, Representation of logic functions - SOP and POS forms, Introduction to K-map representations - Minimization using K maps (Simple Problems only) – Adder and Subtractor (Half and Full) – Multiplexer, Demultiplexer.

Unit V Measurement and Instrumentation **9**

Functional elements of an instrument, Standards and calibration, Operating principle - Moving Coil and Moving Iron meters, Measurement of three-phase power, Instrument transformers - Current and Potentiometer Transformer, DSO- Block diagram.

Total Hours: 45

List of Experiments:

1. Verification of Ohms law.
2. Speed control of DC Motor by armature resistance control (Simulation).
3. Determination of transformer equivalent circuit from open circuit and short circuit test (Simulation).
4. VI characteristics of PN junction diode.
5. Voltage regulation using Zener Diode.
6. Implementation of Boolean Functions.
7. Implementation of Adder and Subtractor.
8. Study of Digital Storage Oscilloscope.

Total Hours: 30

References:

1. ***Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering",*** Second Edition, McGraw Hill Education, 2020.
2. ***S.K.Bhattacharya "Basic Electrical and Electronics Engineering",*** Pearson Education, Second Edition, 2017.
3. ***Sedha R.S., "A Textbook Book of Applied Electronics",*** S. Chand & Co., 2008
4. ***A.K. Sawhney, PuneetSawhney "A Course in Electrical & Electronic Measurements & Instrumentation"***, Dhanpat Rai and Co, New Delhi, 2021.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Compute the simple electric circuit parameters.
CO2: Explain the working principle and test the electrical machines.
CO3: Analyze the characteristics of analog electronic devices.
CO4: Apply the basic concepts of digital electronics.
CO5: Explain the operating principles of measuring instruments.

CO-PO MAPPING

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

Programming for Problem Solving using C

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 3T**

24BEES02 **No. of credits: 3**

Course Learning Objectives:

CLO1: To understand the basic programming constructs for problem solving.

CLO2: To apply the basic knowledge in programming concepts and problem solving using C.

Unit I Computational Thinking and Problem Solving 9

Fundamentals of Computing – Identification of Computational Problems -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 Introduction to C - Data types, Expressions and Statements 9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements- Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process- Introduction to Arrays: Declaration- Initialization – One dimensional array –Two dimensional arrays - String operations: length- compare- concatenate- copy – Selection sort- linear and binary search.

Unit III Functions and Pointers 9

Modular programming - Function prototype- function definition- function call- Built-in functions (string functions- math functions) – Recursion- Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value- Pass by reference.

Unit IV Structures and Union 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility.

Unit V File Processing 9

Files – Types of file processing: Sequential access- Random access – Sequential access file - Random access file - Command line arguments.

Total Hours: 45

References:

1. ***Yashwant Kanetkar(2020). Let us C.***17th Edition, BPB Publications.
2. ***Byron S. Gottfried, Jitendar Kumar Chhabra (2018). Programming with C.***fourthedition, Tata McGraw Hill Publishing Company., New Delhi.
3. ***Paul Deitel and Harvey Deitel(*2018*).C How to Program with an Introduction to C+.*** Eighth edition, Pearson Education.
4. ***ReemaThareja (2016). Programming in C.*** Second Edition, Oxford University Press.
5. ***Kernighan, B.W and Ritchie, D.M (2015). The C Programming language.*** Second Edition, Pearson Education.

Course Outcomes:

At the end of the course, students will be able to :

CO1: Learn the basic algorithmic concepts used to solve simple computational problems.

CO2: Explain the basic constructs of C programming language.

CO3: Identify the importance of functions and pointers.

CO4: Differentiate the applications of structures and union.

CO5: Analyze the working of various file processing techniques.

CO-PO MAPPING

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

Programming for Problem Solving using C Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 2P**

24BEES05 **No. of credits: 1**

Course Learning Objective:

CLO1: To understand and gain knowledge on the basic concepts in C programming language.

List of Experiments:

1. Write a C program to implement I/O Statements.
2. Write a C program to implement Operators.
3. Develop and execute a C program using Switch Case Statements.
4. Develop and execute a C program using Conditional Statements.
5. Write a C program to implement Looping Statements.
6. Develop and execute a C program for 1D & 2D-Arrays.
7. Execute a C program to perform Strings operations.
8. Write a C program to implement Functions and Recursive Functions.
9. Write a C program to implement various Parameters passing methods of Functions.
10. Write a C program to implement Structures and Unions.
11. Write a C program to implement Pointers.
12. Write a C program to implement Files.

Total Hours: 30

Software Requirements:

Turbo C

References:

1. ***Yashwant Kanetkar (2020). Let us C.***17th Edition, BPB Publications.
2. ***Byron S. Gottfried, Jitendar Kumar Chhabra (2018). Programming with C.*** *F*ourth edition, Tata McGraw Hill Publishing Company., New Delhi.
3. ***Paul Deitel and Harvey Deitel (*2018). *C How to Program with an Introduction to C*+. Eighth edition, Pearson Education.
4. ***ReemaThareja (2016). Programming in C.*** Second Edition, Oxford University Press.
5. ***Kernighan, B.W and Ritchie, D.M (2015). The C Programming language.*** Second Edition, Pearson Education.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Experiment the fundamental concepts, control statements and functions in C programming.

CO2: Apply Structures, Union, Pointers and File concepts in C Programming to provide solutions to real world applications.

CO3: Analyze real world problems and use appropriate concepts in C programming to solve it.

CO-PO MAPPING

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

Engineering Practices Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering)

Semester I **Hours of Instruction/week: 4P**
24BEES06 **No.of credits:2**

Course Learning Objectives:

CLO1: To study the hardware and software's and gain knowledge on MATLAB and Linux.

CLO2: To study the domestic wiring, measure the various electrical parameters, verify logic gates and to develop a circuit using electronic components.

List of Experiments:

Computer

PC Hardware and Software

1. System Assembling, Disassembling of parts/peripherals and Hardware Troubleshooting.

MS office

2. Create a document in MS Word which includes Formatting Fonts- Drop cap-Applying Text Effects - Using Character Spacing - Borders and Colors - Inserting Header and Footer - Using Date and Time option.
3. Create a PPT to present your assignment in MS Power Point which includes Basic power point utilities and tools like PPT Orientation – Slide layouts fa–Inserting Text-Word Art –Formatting Text-bullets and Numbering – Auto Shapes –Lines and Arrows.
4. Prepare students grade sheet in excel using basic functions like Sorting-Conditional Formatting –Embedded Chart- Formulas Setting- Page Layout – Spread the content of one cell over many cells-Merge Cells – split Cells – Filters – Freeze Panels – Interactive Buttons – Data protection.

MATLAB

5. Introduction to MATLAB – To define & use variables – vectors – Matrices & Its functions in MATLAB.
6. To study various arithmetic operators and mathematical functions in MATLAB and to create & use m-files.

Operating System

7. Installation of Windows Operating System and Working with basic Unix/ Linux commands.

Software Requirements: MS office, MATLAB and Red Hat Linux.

Electrical & Electronics

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Staircase wiring.
3. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
4. (i) Identification and study of electronic components and equipments – Resistors, capacitors, inductors, colour coding and measurement.
   (ii) Identification and verification of logic gates.
5. Soldering and testing of simple electronic circuits.
6. Assembling and testing of simple electronic components on PCB.

Total Hours: 60

Course Outcomes:

At the end of the course, students will be able to:

CO1: Implement various tasks using MS Word, Power Point, and Excel.

CO2: Apply various commands in MATLAB and Linux.

CO3: Construct various types of domestic wiring, measure the various electrical parameters, verify logic gates and develop a circuit using electronic components.

CO-PO MAPPING

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

Environmental Science

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester I **Hours of Instruction /week: 3T**
24BEMC01 **No. of credits: NCMC**

Course Learning Objective:

CLO 1: To study the interrelationship between living organisms and environment and to help students understand the various environment problems that we face and develop possible solutions to them.

Unit I Environment, Ecosystems and Biodiversity 11

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity- definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds.

Field study of simple ecosystems – pond, river, hill slopes, etc.

Unit II Natural Resources 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

Unit III Environmental Pollution 9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– solid waste management: causes, effects and control measures of municipal solid

wastes – role of an individual in prevention of pollution – pollution case studies–disaster management: floods, earthquake, cyclone and landslides.
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

Unit IV Social Issues and the Environment 9

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act– Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

Unit V Human Population and the Environment 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health –Case studies.

Total Hours: 45

References:

1. ***Raman Sivakumar, "Introduction to Environmental science and Engineering",*** McGraw Hill Education, ISBN 13: 9780070672802, 2009.
2. ***Gilbert M.Masters, 'Introduction to Environmental Engineering and Science'***, 3rd edition, Pearson Education, ISBN-13: 9780131481930, 2008.
3. ***Benny Joseph, 'Environmental Science and Engineering'***, Tata McGraw-Hill, New Delhi, ISBN-13 9789387432352**,** 2006.
4. ***R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards'***, Vol. I and II, Enviro Media.ISBN:8186421017.
5. ***Dharmendra S. Sengar, 'Environmental law***', Prentice Hall of India Pvt. Ltd., New Delhi, ISBN-13**:** 978-8120330597, 2007.
6. ***Rajagopalan, R, 'Environmental Studies-From Crisis to Cure***', Oxford University Press, ISBN**:**9780199459759, 2005 .

Course Outcomes:

At the end of the course, students will be able to:

CO1: Will be familiar with various ecosystems and biodiversity and their importance in maintaining ecological balance.

CO2: Will be able to understand the relevance and importance of natural resources in the sustenance of life on earth.

CO3: Will be able to list different types of pollutions and their impacts on air, water and soil quality and suggest suitable measures to mitigate these impacts.

CO4: Will gain knowledge on the various environmental problems related to social issues and possible solutions to such problems.

CO5: Will be able to correlate human population growth to environmental degradation

CO-PO MAPPING

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

Universal Human Values (Understanding Harmony and Human Conduct)

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of instruction/week: 2T+1Tu**
24BEHS02 **No. of Credits: 3**

Course Learning Objectives:

CLO1: To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' in all the core aspirations of all human beings.

CLO2: To facilitate the development of a Holistic perspective among students towards life and profession based on a correct understanding of Human reality and the rest of existence.

CLO3: To highlight conceivable implications of such a Holistic understanding in terms of ethical human conduct and interaction with Nature.

CLO4: To provide a much-needed orientation input in value education to the young enquiring minds.

Unit I Introduction to Value Education **9**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations

Unit II Harmony in the Human Being **9**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

Unit III Harmony in the Family and Society **9**

Harmony in the Family–the Basic Unit of Human Interaction, 'Trust'–the Foundational Value in Relationship, ' Respect'– as the Right Evaluation, Other Feelings, Justice in Human-to Human Relationship, Understanding Harmony in the Society, Vision or the Universal Human Order.

Unit IV Harmony in the Nature/Existence **9**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

Unit V Implications of the Holistic Understanding – a Look at Professional Ethics **9**

Natural Acceptance of Human Values, Definitiveness of(Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Total Hours: 45

References:

1. ***Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria***, Excel Books, New Delhi, 2010.
2. ***JeevanVidya: EkParichaya, ANagaraj, JeevanVidyaPrakashan***, Amarkantak,1999.
3. ***Human Values, A.N. Tripathi***, New Age Intl. Publishers, New Delhi, 2004.
4. ***The Story of Stuff (***Book).
5. ***The Story of My Experiments with Truth*** - by Mohandas Karamchand Gandhi
6. ***Small is Beautiful*** - E. F Schumacher.
7. ***Slow is Beautiful*** - Cecile Andrews
8. ***Economy of Permanence*** - J C Kumarappa
9. ***Bharat Mein Angreji Raj***–PanditSunderlal
10. ***Rediscovering India*** - by Dharampal
11. ***Hind Swaraj or Indian Home Rule*** - by Mohandas K. Gandhi
12. ***India Wins Freedom*** - Maulana Abdul Kalam Azad
13. ***Vivekananda*** - Romain Rolland (English)

Course Outcomes:

At the end of the course, students will be able to:

CO1. Understand the human reality and the rest of Existence.
CO2. Comprehend towards what they have understood on human values and relationship.
CO3. Apprehend the interconnectedness, the interdependence, the harmony all around the society.
CO4. Develop the holistic perception towards nature.
CO5. Transform from personnel to Value-based Life and Profession.

CO-PO MAPPING

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

Mathematics – II (Laplace Transforms and Complex Variables)

(Common to Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week:3T+1Tu**
24BESM02 **No. of Credits:4**

Course Learning Objectives:
CLO1: To enhance knowledge in Laplace transforms, vector calculus and its applications.
CLO2: To understand the concepts of complex integration and contour integration.

Unit I Laplace Transform 12

Laplace transform - Definition and sufficient conditions - Transforms of functions - Properties of Laplace transforms - Transforms of derivatives and integrals – Initial value theorem - final value theorem - Transform of periodic functions

Unit II Inverse Laplace Transform 12

Inverse Laplace transform - Properties of inverse Laplace transforms - Convolution theorem - Application to solution of linear ordinary differential equations upto second order with constant coefficients.

Unit III Analytic Functions 12

Function of a complex variable – Analytic function – Necessary conditions-Cauchy – Riemann equations in cartesian coordinates - Sufficient conditions (Proof not included)-Properties of analytic function – Determination of harmonic conjugate by Milne– Thomson method – Conformal mapping – $w = z + a$, az, $1/z$

Unit IV Complex Integration 12

Statement and application of Cauchy's theorem and Cauchy's integral formula – Laurent's expansion – Singularities – Classification – Residues – Cauchy's residue theorem - Contour integration - Unit circle and semi-circular contours (excluding poles on real axis).

Unit V Vector Calculus 12

Gradient - Divergence and Curl – Green's - Gauss divergence and Stoke's theorems (without proof) - Verification of the above theorems and evaluation of integrals using them.

Total Hours: 60

References:

1. ***T.Veerarajan (*2016*), Engineering Mathematics (for semester I and II),*** updated 2nd Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
2. ***P.Kandaswamy, K.Thilagavathy and K.Gunavathy (2014), Engineering Mathematics,*** 10th Revised Edition, S. Chand & Co, New Delhi.
3. ***E.Kreyszig (2014), Advanced Engineering Mathematics***, 8th Edition, John Wiley and Sons (Asia) Ltd, Singapore.
4. ***Dennis G.Zill and Michael R.Cullen (2012), Advanced Engineering Mathematics,*** 2nd Edition, CBS Publishers.

5. ***Srimanta Pal and Subhodh C Bhunia (2012),Engineering Mathematics,*** 9th Edition**,** John Wiley and Sons.
6. ***Dr.B.S.Grewal (2014), Higher Engineering Mathematics***, 43rd Edition, Khanna Publishers, New Delhi.
7. ***Jain R.K. and Iyengar S.R.K. (2007), Advanced Engineering Mathematics,*** 3rd Edition, Narosa Publications, New Delhi.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Apply Laplace transform techniques to solve engineering problems.
CO2: Determine inverse Laplace transforms of various functions.
CO3: Construct analytic functions of complex variables and interpret its transformations.
CO4: Evaluate real and complex integrals using the techniques of complex integration.
CO5: Analyse vector differentiation and vector integration in real world problems.

CO-PO MAPPING

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

Applied Chemistry

(Common to Biomedical Instrumentation Engineering and Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 3T+2P**
24BESC01 **No. of credits:4**

Course Learning Objectives:

CLO1: To provide students with a background in important concepts and principles of Chemistry and use the knowledge gained to describe and solve real technological problems.

CLO2: To impart experimental skills and hands on experience in the use of analytical equipment needed for engineering applications.

Unit I Electrochemistry and Storage Devices 9

Electrochemical cells: Electrode potential, Nernst equation (problems). Reference electrodes: Calomel electrode, glass electrode and measurement of pH, EMF, electrochemical series and its significance. Energy Storage Devices Primary and Secondary Cells, Lechlanche cell, Lead Acid Battery, Nickel Cadmium Battery, Lithium Battery, Charging and Discharging reactions

Unit II Corrosion and its Control 9

Chemical and electrochemical corrosion: principle, mechanism, galvanic corrosion, differential aeration corrosion. Factors influencing corrosion.
Corrosion control: Selection of materials and proper designing, sacrificial anode and impressed current cathodic protection methods, corrosion inhibitors.

Unit III Polymers and Green Chemistry 9

Introduction: Functionality-degree of polymerization. Classification of polymers - Natural and synthetic, thermoplastic and thermosetting. Types of polymerization, mechanism of free radical polymerization, Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Conducting polymers, types, mechanism of conduction and Applications. Green chemistry- Introduction and need for green chemistry, Principles of green chemistry.

Unit IV Nanochemistry 9

Nanomaterials –Types – Size dependence of properties, electrical, optical, magnetic and mechanical properties. Synthesis: sol-gel, electrode position and laser ablation. Characterization – Scanning Electron Microscope and Transmission Electron Microscope Principle and Instrumentation (block diagram). Applications of nanomaterials – medicine, agriculture and electronics.

Unit V Photochemistry and Spectroscopy 9

Photochemistry: Laws of photochemistry-Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Photo processes - fluorescence, phosphorescence and photo-sensitization. Spectroscopy: Electromagnetic spectrum-absorption of radiation-electronic, vibrational and rotational transitions. Estimation of concentration of a coloured solution by colorimetry, UV-Visible and NMR spectroscopy- principles, instrumentation (Block diagram only) and applications.

Total Hours: 45

List of Experiments

1. **pHmetry**
   To find out the strength of given hydrochloric acid by sodium hydroxide.
2. **Conductometry**
   a. Estimation of strength of acids in a mixture of acids.
   b. Estimation of Barium Chloride using Sodium Sulphate.
3. **Potentiometry**
   Estimation of ferrous ion in the given solution.
4. Determination of total hardness of water by EDTA method.
5. Determination of chloride content of water sample by argentometric method.
6. **Corrosion Experiment**
   Weight Loss method
7. Synthesis of a polymer
8. **Viscometry**
   Determination of molecular weight of a polymer
9. Estimation of concentration of a coloured solution using colorimeter
10. **Spectrophotometry**
    Estimation of iron content of water sample

Total Hours: 30

References:

1. ***Jain P. C. & Monika Jain (2015). Engineering Chemistry***. Dhanpat Rai Publishing Company (P) Ltd, New Delhi, ISBN 13: 9788187433170.
2. ***Vairam S., Suba Ramesh (2013) Engineering Chemistry***. Wiley India Pvt Ltd., New Delhi., ISBN 13: 9788126544752.
3. ***ShashiChawla (2013). A Text Book of Engineering Chemistry.*** Dhanpat Rai& Co Pvt. Ltd. 3rd Edition, 10thReprint.
4. ***Dara S.S.,Umare S.S (2010). Engineering Chemistry*. 12th edition,** S.Chand & Company Pvt.Ltd, New Delhi., ISBN : 81-219-0359-9.
5. ***PalannaO.G (2017). Engineering Chemistry***.**2nd Edition**, McGraw-Hill Education (India) Pvt. Ltd.,Chennai, ISBN:9789352605774.
6. ***Kannan P., Ravikrishnan A (2014). Engineering Chemistry***. Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai.
7. ***Dr.Rakesh Kumar, Dr. Kamala Pati Tiwary (2013). A Textbook of Nano Science*** 2nd Edition, S.K.Kataria & Sons, New Delhi.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Apply the principle of electrochemistry in the functioning of energy storage devices.
CO2: Identify the causes of corrosion and the possible techniques to minimise corrosion.
CO3: Familiar with the essential aspects of polymer chemistry and the importance of green chemistry
CO4: Get acquainted with the basics of nano materials, their characterisation and applications.
CO5: Acquire a basic knowledge about the spectroscopic techniques used for the analysis of materials.

CO-PO MAPPING

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

Computer Aided Engineering Graphics

(Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week: 2T+3P**

24BEES08 **No. of credits: 3**

Course Learning Objective:

CLO1: The objective of this course is to develop the students in graphic skill for communication of concepts and ideas in engineering field using AutoCAD software.

Unit I Introduction to Computer Aided Engineering Graphics 15

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Geometrical Constructions.
Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves.

Unit II Projection of Points, Lines and Planes 15

Introduction to Orthographic projections: orthographic projection of points.
Projection of straight lines located in the first quadrant only, determination of true length and true inclination.
Projections of plane surfaces like polygonal lamina and circular lamina, located in first quadrant only.

Unit III Projection of Simple Solids 15

Projection of simple solids like prism, pyramid, and cylinder, Drawing views when the axis of the solid is inclined to one reference plane.

Unit IV Sectioning of Solids 15

Sectioning of simple solids like prisms, pyramids, cylinder, cone and sphere. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

Unit V Isometric, Perspective Projection and freehand sketching 15

Isometric projections, Isometric scale, Isometric views of simple solids, Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including freehand dimensioning. Sketching pictorial views from given orthographic views. Perspective projections of solids.

Total Hours: 45

References:

1. ***Venugopal.K , "Engineering Graphics",*** New Age International (P) Limited, 2008.
2. ***Natarajan K.V, "Engineering drawing and graphics",*** 17th Edition, Private Publisher, Chennai, 2008.
3. ***Bhatt.N.D, "Engineering Drawing" ,*** Charotar Publishing House, 2011.

4. ***Kumar M.S, "Engineering Graphics"***, Ninth edition. D.D. Publications, Chennai, 2007.
5. ***Warren J, Luzadder and John.M.Duff , "Fundamentals of Engineering Drawing"***, Eleventh edition. Prentice Hall of India Pvt., Ltd., 2007.
6. ***Gopalakrishnan K.R*, *"Engineering Drawing (Vol.I& II)",*** Subhass Publications, 2007.
7. ***Bertoline and Wiebe, "Fundamentals of graphics Communication",*** Third edition. McGrawhill, 2007.
8. ***Dhananjay A.Jolhe, "Engineering Drawing with an introduction to AutoCAD",*** Tata McGraw Hill Publishing Company Limited, 2008.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Use various commands in AutoCAD Software.
CO2: Draw orthographic projection of points, lines and plane surfaces.
CO3: Sketch projections of solids.
CO4: Draw projections of sections of solids.
CO5: Prepare isometric and perspective sections of simple solids.

CO-PO MAPPING

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

Programming for Problem Solving using Python

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction /week: 3T**

24BEES09 **No. of credits: 3**

Course Learning Objectives:

CLO1: To understand the basic knowledge in programming concepts and Problem solving using Python.

CLO2: To acquire knowledge on Python data structures, functions, modules and packages.

Unit I Introduction to Python Programming Language 9

Introduction to Python Language and installation- overview on python interpreters- working with python- Numeric Data Types: int- float- Boolean- complex and string and its operations- Standard Data Types: List- tuples- set and Dictionaries- Data Type conversions- commenting in python.

Unit II Variables and Operators 9

Understanding Python variables - Multiple variable declarations - Python basic statements- Python basic operators: Arithmetic operators - Assignment operators - Comparison operators- Logical operators- Identity operators - Membership operators - Bitwise operators - Precedence of operators- Expressions.

Unit III Control Flow and Loops 9

Conditional (if)- alternative (if-else)- chained conditional (if- elif -else)- Loops: For loop using ranges-string- Use of while loops in python- Loop manipulation using pass- continue and break- Regular Expression

Unit IV Functions 9

User Defined Functions- Calling Functions- passing parameters and arguments- Python Function arguments: Keyword Arguments- Default Arguments- Variable-length arguments- Anonymous Functions- Fruitful Functions (Function Returning Values)- Scope of the Variables in a Function - Global and Local Variables- Powerful Lambda functions in python- classes and objects.

Unit V I/O Error Handling, Modules and Packages 9

Introduction- Access Modes- Writing Data to a File- Reading Data from a File- Additional File Methods- Introduction to Errors and Exceptions- Handling IO Exceptions- Run Time Errors- Handling Multiple Exceptions. Modules: Importing Module - Packages - Compositions.

Total Hours: 45

References:

1. ***Paul Deitel and Harvey Deitel (2021).Python for Programmers.*** Pearson Education. First Edition.
2. ***John V Gutta- (2021).Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data.*** Third Edition. MIT Press.
3. ***Eric Matthes (2019). Python Crash Course, A Hands - on Project Based Introduction to Programming.*** Second Edition. No Starch Press.
4. ***Martin C. Brown, "The Complete reference – Python",*** Tata McGraw hill edition 2018.
5. ***Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python",*** Network Theory Ltd., 2011.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Explain the basic constructs of python programming language.
CO2: Learn the various types of variables and operators in Python.
CO3: Acquire the knowledge on control statements.
CO4: Learn the concepts of functions.
CO5: Infer the file operations, exception handling, modules and packages in Python.

CO-PO MAPPING

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

Electric Circuit Analysis

(Common to Biomedical Instrumentation Engineering/ Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 3T**
24BEES10 **No. of credits: 3**

Course Learning Objectives:

CLO1: To introduce the basic concepts of DC and AC circuits and analyse the transient and steady state response.

CLO2: To introduce different methods of circuit analysis using Network theorems, duality and topology.

Unit I Basic Circuits Analysis **9**

Basic Components of Electric Circuits: Charge, Current, Voltage and Power, Voltage and Current Sources, Single – Loop Circuit, Single- Node Pair Circuit, Series and Parallel Connected Sources, Resistors in Series and Parallel, Voltage and Current Division, Mesh and Nodal Analysis for DC circuits, Supermesh and Supernode Analysis.

Unit II Network Theorem **9**

Useful Circuit Analysis Techniques: Linearity and Superposition, Thevinin's and Norton Equivalent Circuits, Maximum Power Transfer, Reciprocity Theorem, Millman's Theorem. Source transformation: Delta-Wye Conversion.

Unit III Sinusoidal Steady State Analysis **9**

Sinusoidal Steady - State Analysis: Characteristics of Sinusoids, Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, Impedance and Admittance, Nodal and Mesh Analysis (RLC circuit), Phasor Diagrams.
AC Circuit Power Analysis: Instantaneous Power, Average Power, Apparent Power and Power Factor, Complex Power.

Unit IV Transient Analysis **9**

Basic RL and RC Circuits, Source- Free RL Circuit, Source-Free RC Circuit, Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response: Parallel Resonance, Series Resonance and Quality Factor.

Unit V Coupled Circuits and Topology **9**

Magnetically Coupled Circuits, Self Inductance, Mutual Inductance, Linear Transformer. An Introduction to Network Topology: Graphs and Trees, Network Incidence Matrices, Basic cut-set and tie-set matrices, Loop and Nodal Analysis.

Total Hours: 45

References:

1. ***Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis",*** McGraw Hill education, 9th Edition, 2020.
2. ***Robert.L. Boylestead, "Introductory Circuit Analysis",*** Pearson Education India, Twelfth Edition, 2014.
3. ***Charles.K.Alexander, Mathew N.O.Sadiku," Fundamentals of Electric Circuits",*** McGraw Hill, Seventh Edition, 2020.
4. ***Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice",*** Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Apply the basic concepts of circuit analysis such as Kirchhoff's laws, mesh current, and node voltage method for the analysis of DC and AC circuits

CO2: Analyze AC and DC circuits using suitable network theorem.

CO3: Examine steady-state response of any R, L and C circuits.

CO4: Analyse the transient response of RLC Circuits

CO5: Explain the concepts of coupled circuits and network topology.

CO-PO MAPPING

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

Programming for Problem Solving using Python Laboratory

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction /week: 2P**

24BEES13 **No. of credits: 1**

Course Learning Objective:

CLO1: To understand and gain knowledge on the basic concepts in Python Programming language.

List of Experiments:

1. Implement basic Python programs using various data types and to declare a variable in different possible ways.
2. Create a string and perform various string operations.
3. a. Create a list and perform the operations such as insert, remove, append, len, pop and clear.
   b. Create a tuple and perform the g operations such as add items, len, check for item in tuple.
4. Create a Dictionary and perform the operations such as print the dictionary items, access items, use get(), change values, use len().
5. Write a Python program to perform arithmetic, logical, assignment and comparison operators.
6. Implement a Python program using Conditional Statements.
7. Implement a Python programs using Looping Statements.
8. Implement a Python programs using Functions.
9. Write a Python program to double a given number and add two numbers using lambda().
10. Write a Python program to implement filter() to filter only even numbers from a given list.
11. Write a Python program to implement map() function to double all the items in the list.
12. Implement a real-time applications using Exception handling(divide by zero error, voter's age validity, student mark range validation).

Total Hours: 30

Software Requirements:

Python IDE.

References:

1. ***Paul Deitel and Harvey Deitel (2021).Python for Programmers.*** Pearson Education. First Edition.
2. ***John V Gutta- (2021).Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data.*** Third Edition. MIT Press.
3. ***Eric Matthes (2019). Python Crash Course, A Hands - on Project Based Introduction to Programming.*** Second Edition. No Starch Press.
4. ***Martin C. Brown, "The Complete reference – Python",*** Tata McGraw hill edition 2018.
5. ***Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python",*** Network Theory Ltd., 2011.

Course Outcomes:

At the end of the course, students will be able to :

CO1: Experiment the fundamental concepts, control statements and functions in Python programming.

CO2: Apply sequence data types concepts in Python programming to provide solutions to solve real world applications.

CO3: Analyze the real world problems and use appropriate concepts in python to solve it.

CO-PO MAPPING

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

Electric Circuit Analysis Laboratory

(Common to Biomedical Instrumentation Engineering/ Electronics and Communication Engineering)

Semester II **Hours of Instruction/week: 2P**
24BEES14 **No. of credits:1**

Course Learning Objective:

CLO1: To make the students verify the basic network theorems and analyze the frequency response of basic circuits.

List of Experiments:

1. Verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Verification of electrical circuit problems using Thevinin's Theorem.
3. Verification of electrical circuit problems using Norton theorem
4. Verification of electrical circuit problems using Super Position Theorem.
5. Verification of electrical circuit problems using Maximum Power Transfer Theorem.
6. Verification of Reciprocity Theorem.
7. Verification of Millman's Theorem.
8. Transient analysis of RL and RC circuits.
9. Determine the frequency response of RLC electric circuit.
10. Design and Simulation of series resonance circuit.
11. Design and Simulation of parallel resonance circuit.
12. Study on functioning of Spectrum Analyzer.

Total Hours: 30

Course Outcomes:

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

CO1: Analyze and verify the basic network theorems

CO2: Analyze the transient response of RLC circuits.

CO3: Design and simulate the frequency response of resonance circuits.

CO-PO MAPPING

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

Constitution of India

(Common to Artificial Intelligence and Data Science/ Biomedical Instrumentation Engineering/Civil Engineering with Computer Application/ Computer Science and Engineering/ Computer Science and Engineering (Artificial Intelligence and Machine Learning)/ Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)/Electronics and Communication Engineering/Food Technology)

Semester II **Hours of Instruction/week:2T**
24BEMC02 **No. of Credits: NCMC**

Course Learning Objectives:

CLO1: To know about historical background of the constitution making and its importance for building a democratic India.
CLO2: Elucidate the functioning of three wings of the government i.e., executive, legislative and judiciary.
CLO3: Expound the value of the fundamental rights and duties for becoming good citizen of India.
CLO4: Analyse the decentralization of power between central, state and local self-government.

Unit I History of Making of the Indian Constitution 6

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

Unit II Contours of Constitutional Rights & Duties 6

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit III Organs of Governance 6

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

Unit IV Local Administration 6

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, Panchayatraj: Introduction, PRI: Zila Pachayat. Elected officials and their roles

Unit V Election Commission 6

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Total Hours: 30

References:

1. ***The Constitution of India, 1950(BareAct),*** Government Publication.
2. **M.V.Pylee, "*Introduction to the Constitution of India*",** 4th Edition, Vikas publication, 2005.
3. ***Durga Das Basu, "Introduction to the constitution of India", (***Student Edition), 19th edition, Prentice-Hall EEE, 2008.

Course Outcomes:

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

CO1: Comprehend the history of Indian Constitution and the various schedules under it.

CO2: Exercise the fundamental rights in proper sense at the same time identifies his/her responsibilities in national building.

CO3: Appreciate and discuss the basic components of Indian constitution, Constitutional rights and duties and various Organs of Governance

CO4: Analyse the Indian political system, the powers and functions of the Union, State and Local Governments in detail

CO5: Understand Electoral Process, Emergency provisions and Amendment procedure.

CO-PO MAPPING

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

Mathematics–III (Transforms, Partial Differential Equations and Applications)

(Biomedical Instrumentation Engineering)

Semester: III **Hours of Instruction/week: 3T+1Tu**

Course Code: 24BESM04 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To impart analytical skills in the students to solve boundary value problems and transform techniques.

CLO2: To serve as a prerequisite for various courses involving signal analysis, modeling and for research.

UNIT - I Fourier Series **12**

Dirichlet's conditions - General Fourier series - Half Range Sine and Cosine series - Parseval's identity - Harmonic Analysis.

UNIT - II Fourier Transform **12**

The infinite Fourier transform - sine and cosine transform - properties - inversion theorem - convolution theorem - Parseval's identity.

UNIT - III Z - Transforms **12**

Definition and properties - inverse Z transforms - Definition - Properties - Simple Problems - Application of Z - Transforms in solving difference equations.

UNIT - IV Partial Differential Equations **12**

Formation of Partial Differential equation by elimination arbitrary constants and arbitrary functions - Solution of standard types of first order equations - Lagrange's equation - Linear partial differential equation of second and higher order with constant coefficients.

UNIT - V Boundary Value Problems **12**

Classification of second order linear partial differential equations - Solutions of one - dimensional wave equation - one - dimensional heat equation - Steady state solution of two dimensional heat equation - Fourier series solution in Cartesian coordinates.

Total Hours: **60**

References:

1 Kandaswamy.P., Thilagavathy. K. & Gunavathy. K. (2007), *Engineering Mathematics, III Semester,* S.Chand & Co, New Delhi, 1st Edition.

2 Veerarajan. T.(2014), *Transforms, Partial Differential Equations and Applications*, Tata McGraw – Hill Publishing Company Limited, New Delhi, 3rd Edition.

3 Kreyzig. E. (2014), *Advanced Mathematics*, John Wiley and Sons. (Asia) Pvt Ltd, Singapore, 9th Edition.

4 Grewal. B. S. (2014), *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 43rd Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop Fourier series for functions

CO2: Solve problems using Fourier transforms

CO3: Solve problems using Z transforms

CO4: Understand basic analytical techniques for solving partial differential equations

CO5: Analyse methods to solve boundary value problems

CO-PO MAPPING

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

Electronic Devices and Circuits

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEES17 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To familiarize with the basic electronic devices and their characteristics

CLO2: To analyze amplifier and oscillator circuits.

UNIT - I Semiconductor Devices **9**

PN junction diode, Zener diode, BJT, JFET, MOSFET, UJT – structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

UNIT - II Power Devices and Display Devices **9**

UJT, Thyristor - SCR, DIAC, TRIAC, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Opto Coupler, Solar cell, CCD.

UNIT - III Amplifiers **9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers - Gain and frequency response – MOSFET small signal model – Analysis of CS, CG and Source follower – Gain and frequency response - High frequency analysis.

UNIT - IV Multistage Amplifiers and Differential Amplifier **9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – MOSFET input stages – tuned amplifiers – Gain and frequency response – Neutralization methods.

UNIT - V Feedback Amplifiers and Oscillators **9**

Advantages of negative feedback – Voltage / Current, Series , Shunt feedback Amplifiers – Positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

Total Hours: **45**

References:

1. Millman and Halkias. (2015). *Electronic Devices and Circuits*. McGraw Hill. 4th Edition.
2. Mohammad Rashid. (2015). *Electronic Devices and Circuits.* Cengage Learning Pvt. Ltd.
3. Salivahanan.S., & Suresh Kumar.N.(2016). *Electronic Devices and circuits.* McGraw Hill. 4th Edition.
4. Robert L. Boylestad & Louis Nashelsky. (2014). *Electronic Devices and Circuit Theory*. Pearson 62 Prentice Hall. 11th Edition.
5. Bhattacharya & Sharma. (2014). *Solid State Electronic Devices*. Oxford University Press. 2nd Edition.
6. Adel .S. Sedra, Kenneth C. Smith (2014), "*Micro Electronic Circuits*", Oxford University Press, 7 th Edition.
7. David A. Bell. (2008). *Electronic Devices and Circuits*. Oxford University Press. 5th Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Discuss the characteristics of semiconductor devices.

CO2: Analyze the characteristics of Power and Display devices

CO3: Design and analyze amplifiers.

CO4: Analyze frequency response of BJT and MOSFET amplifiers.

CO5: Design and analyze feedback amplifiers and oscillator principles.

CO - PO MAPPING

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

Electronic Devices and Circuits Laboratory

Semester: III **Hours of Instruction/week: 3P**
Course Code: 24BEES18 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To test the operating characteristics of basic semiconductor devices and circuits by performing simulation and experiments
CLO2: To test amplifier and oscillator circuits and interpret the results.

List of Experiments:

1. Characteristics of PN Junction Diode
2. Zener diode characteristics & Voltage Regulator
3. Common Emitter input-output characteristics
4. Common Base input-output characteristics
5. FET characteristics
6. SCR characteristics
7. Clippers and Clampers
8. Half wave rectifier & Full wave rectifier
9. BJT as RC coupled amplifier
10. BJT as RC phase shift oscillator
11. Simulation and testing of the above experiments using Multisim software

Total Hours: **45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Determine the VI characteristics of given PN junction diode, Zener diode and Silicon Controlled Rectifier.
CO2: Design, construct and test amplifier and oscillator circuits and interpret the results.
CO3: Verify the theoretical concepts through simulation experiments.

CO - PO MAPPING

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

Human Anatomy and Physiology

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEBC01 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To identify all the organelles of a cell and their function.

CLO2: To acquire the basic knowledge of anatomical features and physiology of various human body systems.

UNIT - I Basic Elements of Human Body **9**

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions. Blood: Composition – Functions - Haemostasis – Blood groups and typing.

UNIT - II Skeletal and Muscular System **9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton. Types of joints and function – Types of cartilage and function. Types of muscles – Structure and Properties of Skeletal Muscle - Changes during muscle contraction - Neuromuscular junction.

UNIT - III Cardiovascular and Respiratory System **9**

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood Vessels – Structure and types - Blood pressure. Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

UNIT - IV Digestive, Endocrine and Excretory Systems **9**

Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract. Structure and function of Endocrinal Glands. Structure of kidney and nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.

UNIT - V Nervous, Reproductive and Sensory System **9**

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS - serve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Male and Female reproductive system. Physiology of Vision, Hearing, Integumentary, Olfactory systems and Taste buds.

Total Hours: **45**

References:

1 Elaine N. Marieb. (2018). *Essential of Human Anatomy and Physiology*. Pearson Education, New Delhi. 9th Edition.

2 Guyton & Hall. (2015). *Text book of Medical Physiology*. Saunders. 13th Edition.

3 Ranganathan.T.S. (2012). *Text book of Human Anatomy.* S.Chand& Co. Ltd., New Delhi.

4 Sarada Subramanyam.K., MadhavanKutty & Singh.H.D. (2012). *Textbook of Human Physiology*. S. Chand and Company Ltd, New Delhi.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Summarize the structure and functions of basic elements of human body.

CO2: Explain the functions of skeletal and muscular system.

CO3: Discuss the structure and physiological functions cardiovascular system and respiratory system.

CO4: Describe the anatomical position and physiology of digestive and execratory system.

CO5: Explain the anatomy and physiology of nervous, reproductive and sensory system.

CO - PO MAPPING

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

Medical Biochemistry

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEBC02 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To probe into the biochemical reactions occurring within the human body.

CLO2: To explore specific analytical methods used to evaluate biochemical parameters crucial for diagnosis.

UNIT - I Biomolecules - Chemistry and Significance of Carbohydrates and Lipids 9

Carbohydrates- Classification, Biomedical Importance, Diabetes-Types, Diagnosis- Blood profile in diabetes with special reference to Hemoglobin A1C, Disorders in Diabetes Mellitus.

Lipids- Classification, Essential Fatty Acids and Cholesterol and their clinical significance Disorders- Fatty liver, Hyperlipidemia, hyperlipoproteinemia and atherosclerosis.

UNIT - II Proteins and Nucleic Acids 9

Proteins- Composition, Classification, Physical and Chemical Properties, Structural Organization of Proteins, Biomedical Importance Enzymes and Isoenzymes- Diagnostic significance.

Nucleic Acids- Structural Components of DNA and RNA, Nucleosides & Nucleotides, Double helical structure of DNA - Watson-Crick model, Various forms of DNA, RNA types-structure Inborn errors of metabolism- One specific example in each - Carbohydrate, Lipids and Nucleic Acid metabolism.

UNIT - III Vitamins and Minerals 9

Vitamins- Classification, Functions and Deficiency symptoms of Fat soluble and Water soluble Vitamins, Hypervitaminosis of A, D, E and K.

Minerals- Classification- macro elements and microelements, Specific Function and Deficiency Disorders, Importance of vitamins and Mineral Supplementations.

UNIT - IV Clinical Diagnostics 9

Liver function tests, Renal function tests, Gastric function tests, Thyroid function tests, Blood and Urine analysis, Urolithiasis, Regulation of Water and Electrolyte balance, Acid-Base balance, Normal Values of Biochemical Parameters, PCR test for COVID.

UNIT - V Analytical Techniques 9

Principle, Instrumentation and Applications of Spectrophotometry with special reference to UV and Visible, Atomic Absorption and Flame Emission Spectrophotometry, Fluorimetry, Ultra centrifugation, Immunoassays- RIA and ELISA, Automation in Clinical Laboratory.

Total Hours: **45**

References:

1 Chatterhaa, M. N., & Shinde, R. (2013). *Textbook of Medical Biochemistry*. Jaypee Brothers Medical Publishers (P) Ltd. 9th Edition.

2 Rifai, N. (2023). *Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics*. Elsevier Health Sciences. 9th Edition.

3 Ferrier, D. R. (2020). *Lippincott illustrated reviews: biochemistry* Wolters Kluwer,

Cop.7th Edition.
4 U Satyanarayana. (2021). *Biochemistry*. Elsevier Health Sciences. 6th Edition.
5 Alan H Gowenlock. (2022). *Varley's Practical Clinical Biochemistry*. CBS Publishers. 6th Edition.
6 Vasudevan. D., Sreekumari. S., & Vaidyanathan. K. (2022). *Textbook of Biochemistry for Medical Students*. Jaypee Brothers Medical Publishers Pvt Limited. 10th Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Gain knowledge on the importance of carbohydrates and lipids and their functions in human body.

CO2: Acquire knowledge on proteins and nucleic acid structure, properties and functions.

CO3: Assess the significance of Vitamins and Minerals.

CO4: Examine organ function tests and diagnostic tools practiced in Diagnostic Laboratories

CO5: Discuss Analytical Techniques and their Significance in Clinical Laboratories

CO - PO MAPPING

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

Biomaterials

Semester: III **Hours of Instruction/week: 3T**
Course Code: 24BEBC03 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To impart knowledge of biomaterials and their properties.
CLO2: To introduce biomaterials as implants.

UNIT - I Introduction to Biomaterials **9**

Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena.

UNIT - II Metallic and Ceramic Materials **9**

Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

UNIT - III Polymeric Implant Materials **9**

Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.

UNIT - IV Tissue Replacement Implants **9**

Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

UNIT - V Testing of Biomaterials **9**

Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.

Total Hours: **45**

References:

1 Temenoff. (2009). *Biomaterials*. Pearson Education India.
2 Bhat, S. V. (2019). *Biomaterials*. Springer Science & Business Media. Netherland.
3 Park, J. B., & Bronzino, J. D. (2003). *Biomaterials - Principles and Applications*. CRC Press.
4 Wong, J. Y., Bronzino, J. D., & Peterson, D. R. (2012). *Biomaterials*. CRC Press.
5 Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2014). *Biomaterials Science: an Introduction to Materials in Medicine.* Elsevier Science.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.

CO2: Identify significant gap required to overcome challenges and further development in metallic and ceramic materials.

CO3: Identify significant gap required to overcome challenges and further development in polymeric materials.

CO4: Create combinations of materials that could be used as a tissue replacement implant.

CO5: Select the testing standards to be applied for biomaterials.

CO - PO MAPPING

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

Biomedical Sensors and Measurement Devices

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEBC04 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the purpose of measurement, methods and the errors associated with the measurements.

CLO2: To know the principle of transduction, design and construction of different transducers and to familiarize with measurement and display devices.

UNIT - I Fundamentals of Measurements **9**

Measurement System – Instrumentation - Classification and Characteristics of Transducers – Static and Dynamic - Errors in Measurements and their statistical analysis- methods of error analysis, uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors– Calibration - Primary and secondary standards.

UNIT - II Displacement, Pressure, Temperature Sensors **9**

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage.
Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics

UNIT - III Photoelectric and Piezoelectric sensors **9**

Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer - Equivalent circuit and its characteristics.

UNIT - IV Signal Conditioning Circuits and Meters **9**

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering, Qmeter, PMMC, MI and dynamometer type instruments - DC potentiometer- Digital voltmeter – Multi meter.

UNIT - V Display Devices **9**

CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Biosensors: transduction mechanism in a biosensor and Classification - Electronic nose.

Total Hours: **45**

References:

1 Helfrick, A. D., & William David Cooper. (2007). *Modern Electronic Instrumentation and Measurement Techniques*. Prentice Hall of India.

2 Sawhney, A. K. (2005). *Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai and Sons.

3 Webster, J. G. (2020). *Medical Instrumentation: application and design*. Wiley.

4 Richard. (2017). *Transducers for Biomedical Measurements: Principles and Applications*. Wiley-Interscience.
5 Fraden, J. (2010). *Handbook of Modern Sensors*. Springer Science & Business Media. 3rd Edition.
6 Doebelin, E. O. (1975, January 1). *Measurement Systems: Application & Design*. Tata McGraw-Hill Education. 6th Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Measure various electrical parameters with accuracy, precision, resolution.
CO2: Select appropriate passive or active transducers for measurement of physical phenomenon.
CO3: Select appropriate light sensors for measurement of physical phenomenon.
CO4: Use AC and DC bridges for relevant parameter measurement.
CO5: Employ multimeter, CRO and different types of recorders for appropriate measurement.

CO - PO MAPPING

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

Biomedical Sensors and Measurement Laboratory

Semester: III **Hours of Instruction/week: 3P**
Course Code: 24BEBC05 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To test the working of biosensors and transducers.
CLO2: To find the value of unknown resistance, capacitance using various bridges.

List of Experiments

1. Determine the value of unknown resistance using Wheatstone bridge
2. Determine the value of unknown capacitance using Schering's bridge
3. Determine the value of unknown capacitance using Wein's bridge oscillator
4. Determine the value of unknown capacitance using Desauty's bridge
5. Measure the low resistance using Kelvin's double bridge
6. Find the value of unknown inductance using a Maxwell's inductance bridge
7. Verify the characteristics of strain gauge
8. Verify the characteristics of piezoelectric transducer
9. Plot the characteristics curve of Thermocouple, Thermistor and RTD
10. Verify the characteristics of Load cell
11. Verify the characteristics of Opto-coupler
12. Verify the characteristics of photoelectric transducer
13. Verify the characteristics of LVDT
14. Measure torque of a rotating shaft using torque measurement trainer kit
15. Testing of ECG equipment using ESA
16. Testing of Infusion pump using Infusion analyzer

Total Hours: **45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Determine the values of unknown resistance, capacitance and inductance using various bridges.

CO2: Demonstrate the working and plot the characteristic curves of strain gauge, Load cell and opto-coupler.

CO3: Analyse the characteristics of thermocouple, thermistor, RTD, piezoelectric and photoelectric transducers and test the ECG equipment and Infusion pump.

CO - PO MAPPING

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

School of Engineering

Consumer Affairs

(Non-credit Mandatory Course)

(Applicable for the B.E. students admitted from the academic year 2024-2025 & onwards)

Semester: III **Hours of Instruction/week: 3T**

Course Code: 24BEMC03

Course Learning Objective (CLOs):

CLO1: To familiarize the students with their rights and responsibilities as a consumer.
CLO2: To expound the social framework of consumer rights and legal framework of protecting consumer rights.

UNIT - I Conceptual Framework **9**

Consumer and Markets: Concept of Consumer, Nature of markets: Liberalization and Globalization of markets with special reference to Indian Consumer Markets, E-Commerce with reference to Indian Market. Concept of Price in Retail and Wholesale, Maximum Retail Price (MRP), Fair Price, GST, labelling and packaging along with relevant laws, Legal Metrology.

Experiencing and Voicing Dissatisfaction: Consumer buying process, Consumer Satisfaction/dissatisfaction-Grievances-complaint, Consumer Complaining Behaviour: Alternatives available to Dissatisfied Consumers; Complaint Handling Process: ISO 10000 suite.

UNIT - II The Consumer Protection Law in India **9**

Objectives and Basic Concepts: Consumer rights and UN Guidelines on consumer protection, Consumer goods, defect in goods, spurious goods and services, service, deficiency in service, unfair trade practice, restrictive trade practice.

Organizational set-up under the Consumer Protection Act: Advisory Bodies: Consumer Protection Councils at the Central, State and District Levels; Adjudicatory Bodies: District Forums, State Commissions, National Commission: Their Composition, Powers, and Jurisdiction (Pecuniary and Territorial), Role of Supreme Court under the CPA with important case law.

UNIT - III Grievance Re-dressal Mechanism under the Indian Consumer Protection Law **9**

Who can file a complaint? Grounds of filing a complaint; Limitation period; Procedure for filing and hearing of a complaint; Disposal of cases, Relief/Remedy available; Temporary Injunction, Enforcement of order, Appeal, frivolous and vexatious complaints; Offences and penalties.

Leading Cases decided under Consumer Protection law by Supreme Court/National Commission: Medical Negligence; Banking; Insurance; Housing & Real Estate; Electricity and Telecom Services; Education; Defective Products; Unfair Trade Practices.

UNIT - IV Role of Industry Regulators in Consumer Protection **9**

I. Banking: RBI and Banking Ombudsman
II. Insurance: IRDA and Insurance Ombudsman
III. Telecommunication: TRAI
IV. Food Products: FSSAI
V. Electricity Supply: Electricity Regulatory Commission
VI. Real Estate Regulatory Authority

UNIT - V Contemporary Issues in Consumer Affairs **9**

Consumer Movement in India: Evolution of Consumer Movement in India. Formation of consumer organizations and their role in consumer protection. Misleading Advertisements and sustainable consumption. National Consumer Helpline, Comparative Product testing, Sustainable consumption and energy ratings.

Quality and Standardization: Voluntary and Mandatory standards; Role of BIS, Indian Standards Mark (1S1), Ag- mark, Hallmarking. Licensing and Surveillance; Role of International Standards: 1SO an Overview

Note: Unit II and III refers to the Consumer Protection Act, 1986. Any change in law would be added appropriately after the new law is notified.

Total Hours: **45**

References:

1 Khanna, Sri Ram, Savita Hanspal, Sheetal Kapoor, and H.K. Awasthi. (2007). *Consumer Affairs*. University Press.

2 Choudharv, Ram Naresh Prasad (2005). *Consumer Protection Law Provisions and Procedure*, Deep and Deep Publications Pvt. Ltd.

3 G. Ganesan and M. Sumathy. (2012). *Globalisation and Consumerism*: *Issues and Challenges*, Regal Publications.

4 Suresh Misra and SapnaChadah (2012). Consumer Protection in India: Issues and concerns, IIPA, New Delhi

5 RajyalaxrniRao (2012), *Consumer is King*, Universal Law Publishing Company

6 Empowering Consumers e-book.

7 The Consumer Protection Act, 1986 and its later versions.

Articles:

1. Misra Suresh, (Aug 2017) "Is the Indian Consumer Protected? One India One People.
2. Raman Mittal, Sonkar Sumit and Parineet Kaur (2016) Regulating Unfair Trade Practices: An Analysis of the Past and Present Indian Legislative Models, Journal of Consumer Policy.
3. Chakravarthy, S. (2014). MRTP Act metamorphoses into Competition Act. CUTS Institute for Regulation and Competition position paper. Available online at www.cuts-international.org/doc01.doc
4. Kapoor Sheetal (2013) "Banking and the Consumer" Akademos (ISSN 2231-0584)
5. Bhatt K. N., Misra Suresh and Chadah Sapna (2010). Consumer, Consumerism and Consumer Protection, Abhijeet Publications.
6. KapoorSheetal (2010) "Advertising-An Essential Part of Consumer's Life-Its Legal and Ethical Aspects", Consumer Protection and Trade Practices Journal, October 2010.
7. Verma, D.P.S. (2002). Regulating Misleading Advertisements, Legal Provisions and Institutional Framework.Vikalpa. Vol. 26:No. 2. pp. 51-57.

Periodicals:

1. *Consumer Protection Judgments (CPJ*) (Relevant cases reported in various issues).
2. *Recent issues of magazines: International Journal on consumer law and practice*, National Law School of India University, Bengaluru.
3. *Consumer Voice.* Published by VOICE Society, New Delhi.

Websites:

www.ncdrc.nic.in
www.consumeraffairs.nic.in
www.iso.org.
www.bis.org.in
www.consumereducation.in
www.consumervoice.in
www.fssai.gov.in
www.cercindia.org

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the concepts of consumer, markets, relevant laws and grievances

CO2: Familiarize with the consumer protection laws, objectives and concepts

CO3: Awareness of Grievance Redressal Mechanism under the Indian Consumer Protection Law and Case studies.

CO4: Comprehend the business firms' interface with consumers and the consumer related regulatory and business environment.

CO5: Awareness of contemporary issues in consumer affairs and knowledge of quality and standards.

CO - PO MAPPING

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

Department of Biomedical Instrumentation Engineering

PCB Design

(Value Added Course)

Semester: III **Hours of instructions/week: 2T**

Course Code: 24BEBV01

Course Learning Objectives (CLOs):

CLO1: To acquire the basic level knowledge and understand the packages of Electronic components, types of PCBs and history of PCBs.

CLO2: To Understand the methods for manufacturing of PCBs and the methods of soldering process.

UNIT - I Introduction **8**

History of Printed Circuit Boards, Various types of Printed Circuit Boards-Single Sided, Boards, Double Sided Plated through Hole Boards, multilayer Boards. Study of Packages of Electronic Components. Study of SMD Components.

UNIT - II PCB Layout Design **8**

PCB Design software packages for schematic capture - Starting a project, Working with schematic design tools, Schematic drawing from circuit. Layout and Artwork making for Single-side, double-side and Multilayer Boards. Design for manufacturability Design-specification standards, placing, editing, and connecting parts and electrical symbols.

UNIT - III PCB Fabrication **8**

Steps involved in fabrication of PCB. PCB Fabrication techniques - single, double sided and multilayer. Etching: chemical principles and mechanisms. Post operations - stripping, black oxide coating and solder masking.

UNIT - IV Transmission lines and crosstalk **8**

Transmission Line - Transmission lines and its effects Significance of Transmission line in Board design Types of Transmission lines. Crosstalk - The crosstalk in transmission lines Crosstalk control in PCB design parts, planes, tracks, connectors, terminations Minimization of crosstalk. Thermal issues - Thermal mapping of design.

UNIT - V Assembly & Soldering Techniques **8**

Mixed Assembly Techniques of through hole and SMDs. Manual Assembly method, Semiautomatic and automatic Assembly method. Study of Tools used in assembly process.

Materials used in Soldering Process. Types of soldering techniques. Soldering Methods –Manual and Mass soldering Techniques. Tools for soldering and de-soldering. Study of soldering defect and rectification. Testing for quality Control.

Total Hours: **40**

References:

1 Walter C Bosshart. (2010). *Printed Circuit Boards: Design and Technology*. Tata McGraw-Hill.

2 S D Mehta. (2011). *Electronic Product Design*. S Chand Publications.

3 RS Khandpur. (2017). *Printed Circuit Board*. Tata McGraw Hill Education Pvt Ltd.

4 Kraig Mitzne. (2009). *Complete PCB Design using OrCAD Capture and PCB Editor*. Newnes.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Discuss the packages of Electronic components, types of PCBs and history of PCBs.

CO2: Design PCB Layout.

CO3: Illustrate the steps involved in fabrication of PCB.

CO4: Describe basic concepts of transmission line, crosstalk and thermal issues.

CO5: Design and fabricate PCB for simple circuits.

CO - PO MAPPING

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

Biomedical Waste Management

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BEHS03 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To ensure safe practices and proper management of different types of medical waste, in order to safeguard the patient, community and the environment.

CLO2: To be aware of cross infections through biomedical wastes and bioethics for handling hospital generated wastes.

UNIT - I Healthcare Hazard Control and Understanding Accidents 9

Healthcare Hazard Control: Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education and Training.

UNIT - II Types of Biomedical Waste and Segregation 9

Biomedical Waste Management: Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment, and disposal.

UNIT - III Hazardous Materials 9

Hazardous Materials: Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

UNIT - IV Facility Safety 9

Facility Safety: Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.

UNIT - V Infection Control, Prevention and Patient Safety 9

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Blood borne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.

Total Hours: **45**

References:

1 Anantpreet Singh, & Sukhjit Kaur. (2012). *Biomedical waste disposal*. Jaypee Brothers Medical Pub.

2 Tweedy, J. T. (2014). *Healthcare hazard control and safety management*. CRC Press.

3 Goyal, R. C. (2013). *Hospital Administration and Human Resource Management*. PHI Learning Pvt. Ltd. 4th Edition.

4 Landrum.V.J. (1991). *Medical waste management and disposal*. Elsevier. Noyes Data Corp.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Illustrate the segregation and disposal of biomedical wastes.

CO2: Comprehend the cross infections through hospital generated wastes and its prevention.

CO3: Explain the awareness and seriousness in handling biomedical waste.

CO4: Design different safety facility in hospitals.

CO5: Propose various regulations and safety norms.

CO - PO MAPPING

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

Numerical Techniques

(Biomedical Instrumentation Engineering)

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BEES24 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the fundamental mathematical concepts and mastering problem solving skills using numerical methods.

CLO2: To introduce the numerical techniques of interpolation, ordinary and partial differentiation which plays an important role in engineering and technology discipline?

UNIT - I Numerical Methods for Linear Simultaneous Equations 9

Linear simultaneous equations - Gauss elimination method - Gauss Jordan method - Crout's method - Gauss Seidel iterative method.

UNIT - II Numerical Methods for Non Linear Equations 9

Solution of a non linear equation - Bisection method - Newton Raphson method - Rate of convergence - Solution of a system of non linear equations.

UNIT - III Interpolation 9

Introduction - Gregory-Newton forward and backward interpolation formulae - Equidistant terms with one or more missing values - Gauss forward and backward interpolation formulae - Bessel's formula - Laplace Everett formula.

UNIT - IV Numerical Methods for Ordinary Differential Equations 9

Ordinary differential equations: Initial value problems - Taylor series - Picard's method - Fourth order Runge - Kutta methods - Predictor Corrector methods - Milne's and Adams Bashforth Method.

UNIT - V Numerical Methods for Partial Differential Equations 9

Finite difference approximations to partial derivatives - Finite difference method for elliptic parabolic equations - One dimensional heat flow - Bender Schmidt recurrence relation - Liebmann procedure for Laplace equation.

Total Hours: **45**

References:

1 Burden. R.L & Faires. J.D (2016), *Numerical Analysis*, Cengage Learning, 9th Edition.

2 Grewal. B.S. & Grewal. J.S (2015), *Numerical Methods in Engineering and Science*, Khanna Publishers, New Delhi, 10th Edition.

3 Sastry. S. S (2015), *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd., 5th Edition.

4 Kandaswamy.P., Thilagavathy. K. & Gunavathy. K. (2013), *Engineering Mathematics, III Semester*, S.Chand & Co, New Delhi, Numerical Methods, S.Chand & Co.Ltd, Delhi, 1st Edition.

5 T.Veerarajan (2004), Numerical *methods with programs in C and C++*, Tata Mc Graw Hill publishing company Ltd, New Delhi.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Solve linear simultaneous equations using numerical techniques.

CO2: Solve nonlinear equations using various numerical methods.

CO3: Understand the use of interpolation and implement different interpolation schemes.

CO4: Acquire the knowledge of various techniques and methods in solving ordinary differential equations.

CO5: Apply various numerical techniques to solve partial differential equations.

CO - PO Mapping

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

Pathology and Microbiology

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BEBC06 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To gain knowledge on the structural and functional aspects of living organisms.

CLO2: To learn about the cause, mechanism and diagnosis methods of pathological disease.

UNIT - I Cell Physiology **9**

Normal cell structure, Cell degeneration and regeneration, Inflammations. Neoplasia, Classification, Difference between benign and malignant tumors, Etiology of tumors, spread of tumors.

UNIT - II Tissue Processing Techniques **9**

Tissue processing, Histokinates Block making. Microtome and knives. Cryostat, frozen section. Basic stain and special stains (fat, iron stains).

UNIT - III Infections and Diseases **9**

Infection and immunity, Serodiagnosis of infections, Diseases, Diseases produced by bacteria, Diseases produced by viruses, Diseases produced by fungi.

UNIT - IV Study of Bacterial Cell **9**

Physiology of a bacterial cell, growth and identification of bacteria, observation of cultures. Microscope, Light Microscopy, Phase contrast microscopy, Electron microscopy.

UNIT - V Control of Diseases and Infections **9**

Disinfection, Sterilization: heat, filtration, chemicals and radiation, Immunization programs: Vaccination, Immunological tolerance, Regulation of the immune response, Infectious disease epidemics: Origin and spread, Population characteristics, infecting agent, Approaches to Control infectious diseases, Infectious diseases in hospitals, Infectious disease control network.

Total Hours: **45**

References:

1 Mohan.H., & Damjanov.I. (2019). *Textbook of pathology*. Jaypee Brothers Medical Publishers. 9th Edition.

2 Nester, E.W., Evans Roberts.C, Nester, M.T., & Deangelis, C. A. (2019). *Microbiology: A human perspective*. McGraw Hill Higher Education.

3 Vinay Kumar, Abbas, A. K., & Aster. J. C. (2015). *Pathologic Basis of Disease.* Elsevier Health Sciences. 9th Edition.

4 Jayaram Paniker.C.K, & Ananthanarayan.R. (2017). *Ananthanarayan and Paniker's Textbook of Microbiology.* Orient Longman.

Course Outcomes:

At the end of the course, students will be able to:

- **CO1:** Recall the structural and functional aspects of living organism and analyze the pathology of disease caused by various organisms.
- **CO2:** Explain the etiology of tumors, spread of tumors and summarize the different tissue processing techniques.
- **CO3:** Comprehend the role of bacteria, viruses and fungi and ways of preventing/ treating viral infections.
- **CO4:** Discuss the microscopic techniques used for identification and growth of pathogenic organisms.
- **CO5:** Describe the various sterilization procedures and gain knowledge on immunization programs.

CO - PO MAPPING

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

Signal Processing

Semester: IV **Hours of Instruction/week: 3T+1Tu**

Course Code: 24BEBC07 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To grasp the principles of CT and DT signals and systems and to acquire proficiency in analyzing LTI systems through the application of Laplace and Z transforms.

CLO2: To represent the signal in frequency domain using FFT and gain knowledge about the design of IIR and FIR filters.

UNIT - I Fundamentals of Signals and Systems **12**

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT - II Analysis of LTI Systems **12**

Fourier Series - Fourier Transform and Properties, Analysis of Continuous Time LTI Systems – Z Transform - Properties of ROC– Inverse Z Transform – DTFT - Analysis of Discrete Time LTI Systems.

UNIT - III Discrete Fourier Transform **12**

DFT and its properties, magnitude and phase representation-Linear Convolution- Correlation Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm. Use of FFT in Linear Filtering.

UNIT - IV Infinite Impulse Response Filters **12**

Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade and parallel forms.

UNIT - V Finite Impulse Response Filters and Multirate Signal Processing **12**

Design of linear phase FIR filters - windowing and Frequency sampling methods. Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR and IIR. Introduction to DSP processors. Introduction to Multirate signal Processing – Decimation and Interpolation.

Total Hours: **60**

References:

1 Oppenheim, A. V., Buck, J., Daniel, M., Willsky, A. S., Syed Hamid Nawab, & Singer, A. (2015). *Signals & Systems*. Pearson Educación.

2 Proakis, J. G. (2014). *Digital Signal Processing: Principles Algorithms and Applications*. Pearson Education India.

3 Haykin, S., & Barry Van Veen. (2007). *Signals and Systems*, 2nd Ed. John Wiley & Sons.

4 Lathi, B. P. (2017). *Principles of Linear Systems and Signals*. Oxford University Press.

5 Ifeachor, E. C., & Jervis, B. W. (2002). *Digital Signal Processing : A Practical Approach*.

Addison Wesley.
6 Hayes, M. H. (2012). Digital Signal Processing, Schaum's outlines, Mcgraw-Hill.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Classify the continuous time and discrete time signals and systems.

CO2: Analyze the signals in both continuous time and discrete time.

CO3: Apply DFT for the analysis of digital signals & systems.

CO4: Design IIR filter to process real world signals.

CO5: Design FIR filter to process real world signals.

CO - PO MAPPING

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

Control Systems

Semester: IV **Hours of Instruction/week: 3T+1Tu**

Course Code: 24BEBC08 **No. of credits: 4**

Course Learning Objectives (CLOs):

CLO1: To understand the concepts of design and analysis of control systems.

CLO2: To analyze the stability of the control systems and state space representation.

UNIT - I Systems and their Representation **12**

Basic elements in control systems, Open and closed loop system, Methods of analysis of Physical systems, Electrical analogy of physical systems, AC and DC servomotor, Transfer function and block diagram, Reduction techniques for block diagram, Signal flow graph.

UNIT - II Time Response **12**

Time domain specifications, Types of test inputs, I and II order system responses, Error coefficients, generalized error series, Steady state error.

UNIT - III Frequency Response **12**

Determination of closed loop response from open loop response, Bode plot, Nichol's chart, Polar plot.

UNIT - IV Stability of Control Systems **12**

Characteristic equation, Location of roots in S, plane for stability, Routh Hurwitz criterion, Root locus techniques, Construction, Gain margin and phase margin, Nyquist stability criterion.

UNIT - V State Space Analysis **12**

State Space representation of SISO and MIMO systems using physical variables, Phase variables and canonical variables, State transition matrix, Solution of state equations. Transfer function from state model and Transfer matrix.

Total Hours: **60**

References:

1 Nagrath, I. J., & Gopal, M. (2018). *Control Systems.* New Age Publications.

2 Ogata, K. (2013). *Modern Control Engineering*. Prentice Hall. 5th Edition

3 Kuo. B. C. (2012). *Automatic Control Systems*. Wiley and Sons Pvt. Ltd

4 Salivahanan.S., Rengaraj.R., and Venkatakrishnan.G.R. (2015). *Control Systems Engineering,* Pearson Education India.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Compute the transfer function of different physical systems.

CO2: Analyse the time domain specifications and calculate the steady state error.

CO3: Illustrate the frequency response characteristics of open loop and closed loop system response.

CO4: Analyse the stability using Routh and Root Locus technique.

CO5: Illustrate the state space model of a physical system.

CO - PO MAPPING

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

Analog and Digital Integrated Circuits

Semester: IV **Hours of Instruction/week: 3T**

Course Code: 24BEBC09 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study the circuit configuration and introduce practical applications of linear integrated circuits

CLO2: To introduce the design of various combinational and sequential digital circuits using logic gates.

UNIT - I Operational Amplifier and its Applications 9

Operational amplifier –ideal characteristics, Performance Parameters, Linear and Nonlinear Circuits and their analysis- voltage follower, Inverting amplifier, Non-inverting Amplifiers, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Low pass, High pass filter and band pass filters, Comparator, Multivibrator and Schmitt trigger, Triangular wave generator.

UNIT - II D/A and A/D Converters and PLL 9

Analog switches, High speed sample and hold circuit and IC‘s, Types of D/A converter –Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, Voltage to Frequency converters. PLL-Closed loop analysis of PLL, Frequency multiplication/ division, FSK demodulator.

UNIT - III The Basic Gates and combinational Logic Circuits 9

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, 84-2-1, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map and Tabulation methods. Logic families- TTL, MOS, CMOS, BiCMOS – Comparison of Logic families.

UNIT - IV Combinational Logic Circuits 9

Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux.

UNIT - V Sequential Logic Circuits 9

Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – state minimization, state assignment and circuit implementation. Counters, Ripple Counters, Ring Counters. Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register.

Total Hours: **45**

References:

1 Franco, S. (2017). *Design with Operational Amplifiers and Analog Integrated Circuits*. McGraw-Hill Companies. 3rd *Edition.*

2 Wakerly, J. F. (1990). *Digital Design: principles and practices*. Prentice Hall. 5th Edition.

3 Taub, H., & Schilling, D. (2017). *Digital integrated electronics*. McGraw-Hill.

4 Roth, C. H., & Kinney, L. L. (2014). *Fundamentals of logic design.* Cengage Learning. 7th Edition.

5 M Morris Mano, & Ciletti, M. D. (2018). *Digital design.* Pearson. 6th Edition.

6 Salivahanan.S. and Kanchana Bhaaskaran.V.S. (2018). *Linear Integrated Circuits*. McGraw Hill Education. 3rd Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Develop linear IC based Systems.

CO2: Apply the concept of ADC and DAC in real time systems and Phase Locked Loop with applications.

CO3: Use Boolean algebra and apply it to digital systems.

CO4: Design various combinational digital circuits using logic gates.

CO5: Design synchronous and asynchronous sequential circuits.

CO - PO MAPPING

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

Integrated Circuits Laboratory

Semester: IV **Hours of Instruction/week: 3P**
Course Code: 24BEBC10 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To design and implement, combinational and sequential logic circuits using gates.
CLO2: To demonstrate simple digital systems for various applications.

List of Experiments

1. Study of logic gates, Half adder and Full adder
2. Encoder and Decoder
3. Code converters
4. Multiplexer and demultiplexer using digital ICs
5. Design of mod-N counter
6. Inverting, non-inverting amplifier
7. Differential amplifier
8. Integrator and Differentiator
9. Active filter –LPF and HPF
10. Schmitt trigger
11. RC phase shift oscillator, Wein bridge oscillator
12. Multivibrator using IC555 Timer
13. Simulation and testing of the above experiments using Multisim software

Total Hours: **45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Design and implement combinational and synchronous sequential circuits using universal gates.
CO2: Construct and test the circuits using operational amplifiers and timer.
CO3: Design and test active filters using operational amplifier.

CO - PO MAPPING

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

Signal Processing Laboratory

Semester: IV **Hours of Instruction/week: 3P**
Course Code: 24BEBC11 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To apply signal processing techniques to practical problems including signal generation, analysis, and manipulation.

CLO2: To design and implement digital filters, conduct spectral analysis, evaluate system stability, and analyze the impact of finite word length and sampling of signal processing systems.

List of Experiments:

1. Construction of signals with different Frequencies.
2. Analyse the stability of a CT System with various inputs.
3. Analyse the stability of a DT System with various inputs.
4. Reconstruct a signal from samples and study the effect of Aliasing.
5. Spectrum Analysis using FFT
6. Filter Design & Analysis.
7. Finite word length effect.
8. Multirate Signal Processing.
9. DSP Processor Implementation. (Linear and Convolution, FFT implementation, IIR and FIR filters implementation)

Total Hours**: 45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Analyze and interpret the characteristics of signals with different frequencies using tools such as Fourier analysis and time-domain analysis.

CO2: Interpret and communicate the implications of stability analysis results in the context of real-world systems and applications.

CO3: Assess the stability of discrete-time systems using methods such as z-transform analysis.

CO - PO MAPPING

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

School of Engineering

Essence of Indian Knowledge Tradition

(Non-credit Mandatory Course)

(Applicable for the B.E. students admitted from the academic year 2024-2025 & onwards)

Semester IV **Hours of Instruction/week: 3T**

Course Code: 24BEMC04

Course Learning Objectives (CLOs):

CLO1: Gain knowledge in Indian Philosophical Foundations.
CLO2: Know Indian Languages and Literature and the fine arts in India & their Philosophy.
CLO3: Explore the Science and Scientists of Medieval and Modern India.

UNIT - I Introduction to Indian Philosophy **9**

Basics of Indian Philosophy, culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian culture, Ancient Indian, Medieval India, Modern India.

UNIT - II Indian Philosophy & Literature **9**

Vedas Upanishads, schools of Vedanta, and other religion Philosophical Literature. Philosophical Ideas the role of Sanskrit, significance of scriptures to current society, Indian Philosophies, literature of south India. Indian languages and Literature-II: Northern Indian languages & Philosophical & cultural & literature.

UNIT - III Religion and Philosophy **9**

Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).

UNIT - IV Indian Fine Arts & Its Philosophy (Art, Technology & Engineering) **9**

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in Indian, development of science in ancient, medieval and modern Indian.

UNIT - V Education System in India **9**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Total Hours**: 45**

Reference Books:

1. Kapoor, K. (2005). *Text and Interpretation: The India Tradition*.
2. *Science in Samskrit*. (2007). Samskrita Bharti Publisher.
3. NCERT – "*Position paper on Arts, Music, Dance and Theatre*".
4. Narain, S. (1993). *Examinations in Ancient India*.
5. Prakash, S. (1989). *Founders of Sciences in Ancient India*.
6. Mysore Hiriyanna. (2008). *The essentials of Indian philosophy*. Motilal Banarsidass Publishers.

7. Satischandra Chatterjee, & Dhirendra Mohan Datta. (2016). *An introduction to Indian philosophy*. Motilal Banarsidass Publishers Private Limited.

Course Outcomes:

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

CO1: Understand philosophy of Indian culture
CO2: Distinguish the Indian languages and literature among difference traditions
CO3: Learn the philosophy of ancient, medieval and modern India.
CO4: Acquire the information about the fine arts in India.
CO5: Know the contribution of scientists of different eras.

CO, PO MAPPING

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

Analog and Digital Communication

Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBC12 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn and compare analog and digital communication techniques.
CLO2: To familiarize with source and error control coding and gain knowledge wireless communication.

UNIT - I Analog Communication **9**

Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of AM, DSBSC, SSBSC, VSB Techniques. AM Modulators and Demodulators, AM Transmitter and Receiver –TRF and Super-heterodyne Receiver- Angle Modulation, FM & PM Modulators and Demodulators, FM Transmitter- Direct method, Indirect method, FM Receiver, Comparison of various Analog Communication System (AM – FM – PM).

UNIT - II Digital Communication

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) – Phase Shift Keying (PSK)– BPSK – QPSK – 8 PSK - Quadrature Amplitude Modulation (QAM) – 8 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT - III Pulse Modulation **9**

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM), DPCM, DM, ADPCM & ADM, Channel Vocoder – TDM, FDM, Comparison of various Pulse Communication System (PAM – PTM – PCM).

UNIT - IV Source and Error Control Coding **9**

Entropy, Source encoding theorem, Shannon Fano coding, Huffman coding, Mutual information, Channel capacity, Channel coding theorem, Error Control Coding, Linear block codes, Cyclic codes, Convolution codes.

UNIT - V Wireless Communication System **9**

Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA), Cellular Concept and Frequency Reuse – Channel Assignment and Hand off –Satellite Communication: Kepler‟s Law – Satellite orbit – Geostationary Satellite –Satellite link modes – Bluetooth – Wi-Fi.

Total Hours: **45**

References:

1 Tomasi, W. (2015). *Advanced Electronic Communications Systems*. Prentice Hall. 6th Edition.
2 Haykin. (2006). *Communication Systems*. John Wiley & Sons. 4th Edition.
3 Rappaport. (2018). *Wireless Communications: Principles and Practice.* Pearson Education India. 2nd Edition.
4 Taub, H. (2018). *Principles Of Communication Systems*. Tata McGraw-Hill Education. 4th Edition.

5 Kennedy, G., & Davis, B. (2016). *Electronic communication systems*. Lake Forest, Ill. Mcgraw-Hill. 5th Edition.

6 Lathi. B. P. (2007). *Modern digital and analog communication systems*. Oxford University Press. 3rd Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Evaluate the performance of AM, FM and PM systems.
CO2: Discuss the various shift keying techniques used in digital communication systems.
CO3: Analyze the performance of PAM, PTM and PCM modulation techniques.
CO4: Analyze source and error control coding and apply multi-user radio communication.
CO5: Illustrate the concepts of wireless communication systems.

CO - PO MAPPING

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

Medical Diagnostic Equipment

Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBC13 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire knowledge on principle, working and application of diagnostic equipment.
CLO2: To be able to differentiate an appropriate diagnostic equipment usage for various testimonies.

UNIT - I Cardiac Equipment **9**

ECG; continuous monitoring systems for pulse rate, temperature, B.P. Respiration, Arrhythmia monitor; B.P. monitor, Blood flow and cardiac output, Measurement, Plethysmography, Oximetry, Treadmill (Stress ECG).

UNIT - II Electro-physiological Equipment **9**

EMG, EEG, EOG, ERG. Audiometer, Different modes and assessments.

UNIT - III Clinical Equipment - I **9**

UV, Visible and IR Spectrophotometers, Flame Photometers, Electrolyte analysis using sensitive electrodes, pH meter, principle and applications. Densitometer and Electrophoresis apparatus.

UNIT - IV Clinical Equipment - II **9**

Principles and applications of oil, gas and liquid chromatographs, Mass Spectrometry, Flow Cytometry, Radio immune assay and ELISA techniques, Blood gas analyzers, Blood cell counters.

UNIT - V Optical Equipment **9**

Various types of Endoscopes, Fiber optic, Fluid optic, Integral Camera. Electron Microscope, Transmission and Reflection.

Total Hours: **45**

References:

1 R.S. Khandpur. (2014). *Handbook of Biomedical Instrumentation*. McGraw-Hill Education. 3rd Edition.

2 Geddes, L. A., & Baker, L. E. (2016). *Principles of applied biomedical instrumentation*. J. Wiley. 3rd Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Describe the principle behind Cardiac, Electro-physiological, Clinical and Optical Equipment.
CO2: Illustrate the working, and differentiate between the diagnostic equipment.
CO3: Analyze the principles and applications of clinical equipment.
CO4: Design circuits, modify and identify the malfunctioning accessories in the equipment.
CO5: Identify the advantages and disadvantages of diagnostic applications.

CO - PO MAPPING

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

Medical Therapeutic Equipment

Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBC14 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the basic principles and working of medical therapeutic equipment.
CLO2: To develop core competency in the field of Biomedical Engineering, in order to design and develop new health care devices.

UNIT - I Cardiac Equipment **9**

Cardiac Pacemakers-External and Implantable pacemakers, Programmable pacemakers, Power sources, Encapsulation and leads, Basic design problems, Pacing system analyzers. Cardiac Defibrillators- Basic principles and comparison of different Defibrillators, Energy requirements, Basic design problems, Synchronous operation, Implantable Defibrillators, Defibrillator analyzers.

UNIT - II Respiratory Equipment **9**

Artificial ventilation, Ventilators-Principles of constant pressure and constant volume ventilators, Modes of operation, Basic operation of pneumatic and electronic ventilators, High frequency ventilation, Faults and maintenance procedures.

UNIT - III Electrotherapy Equipment-I **9**

Electro diagnosis, Electrotherapy-Intensity-Time curve, Waveforms for electrotherapy, Diagnostic/ therapeutic stimulating unit, Electrodes for applications, Stimulators for Nerve and Muscle, Stimulator for pain relief, Interferential current therapy, Spinal cord stimulator, Functional Electrical Stimulation. Cervical/Lumbar Traction Machine, Traction Table.

UNIT - IV Electrotherapy Equipment-II **9**

High frequency heat therapy, Principle, Shortwave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy, Therapeutic IR radiation, Therapeutic UV lamps.

UNIT - V Therapeutic Lasers **9**

Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2 laser, He-Ne laser, Nd-YAG and Ruby laser.

Total Hours: **45**

References:

1 R.S. Khandpur. (2014). *Handbook of Biomedical Instrumentation*. McGraw-Hill Education. 3rd Edition.
2 Webster, J. G. (2020). *Medical instrumentation: application and design*. Wiley. 5th Edition.
3 Carr, J. J., & John Michael Brown. (2011). *Introduction to Biomedical Equipment Technology*. Pearson. 6th Edition.
4 Cromwell, L., Weibell, F. J., & Pfeiffer, E. A. (2015). *Biomedical Instrumentation and Measurements*. Prentice Hall. 2nd Edition.
5 Low, J., Robertson, V., Ward, A., Reed, A., & Al, E. (2008). *Electrotherapy explained: principles and practice*. Heidi Harrison. 4th Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand principles and working, and compare operation of cardiac care equipment and apply simple design considerations for circuits using appropriate tools.

CO2: Understand the basic mechanism of ventilation and analysis of pulmonary functions and to demonstrate the use of ventilation therapy.

CO3: Understand the principles of electrotherapy and the operation of equipment used for stimulation for nerve, muscle, pain control and traction.

CO4: Understand the principles of high frequency heat therapy, comparison of operation of machines used, and the principles of Lithotripsy and therapeutic UV and IR.

CO5: Understand the principle and operation of therapeutic lasers in medical applications.

CO - PO MAPPING

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

Biomechanics

Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBC15 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire knowledge on the concepts of biomechanics.
CLO2: Learn the application of biomechanics into modelling and ergonomic design.

UNIT - I Principles of Mechanics **9**

Free-body diagrams and equilibrium, Linear/Angular Kinematics/Kinetics.
Bio fluidics: Biofluid mechanics, Flow properties of blood, Rheology of blood in micro vessels, Measurement/Estimation of In-vivo elasticity of blood vessels. Structures, properties of mechanics of soft and hard tissues (bones, cartilage, muscles, tendon and ligaments).

UNIT - II Application of Finite Element Analysis **9**

Introduction to FEA, Implementation in Biomechanical Engineering, Biomechanical Engineering Analytical models, definition of stress and strain, Soft tissue mechanics- modeling and material properties.

UNIT - III Cardiac Mechanics **9**

Cardio vascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, veins, Pulse wave velocities in arteries, prosthetic heart valves & replacements.

UNIT - IV Orthopaedic Mechanics **9**

Mechanical properties of cartilage, Diffusion properties of articular cartilage, Mechanical properties of bone, Skeletal joints, types of joints, Lubrication of joints.

UNIT - V Orthopaedic Applications **9**

Human locomotion: Gait cycle-parameterization and analysis. Chemistry of normal locomotion, above knee, below knee prosthesis, Foot braces, Multitask exoskeletal walking devices for paraplegics. Biomechanical analysis of scolioticspine, Use of ISIS.

Total Hours: **45**

References:

1 Dhanjoo Ghista. (2008). *Applied Biomedical Engineering Mechanics*. CRC Press.
2 Fung, Y. C. (2013). *Biomechanics*. Springer Science & Business Media.
3 Hall, S. J. (2015). *Basic Biomechanics*. McGraw-Hill Humanities, Social Sciences & World Languages. 7th Edition.
4 Knudson, D. V. (2017). *Fundamentals of biomechanics*. Springer. 3rd Edition.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand and apply principles of equilibrium, kinematics, and kinetics in biomechanical contexts.

CO2: Utilize finite element analysis techniques to model and analyze biomechanical systems.

CO3: Understand of the mechanical properties of the cardiovascular system and analyze pulse wave velocities and mechanical behaviors under various conditions.

CO4: Analyze joint lubrication mechanisms and classify different joint types for orthopaedic applications.

CO5: Analyze human locomotion, designing orthopaedic devices such as prostheses and foot braces.

CO - PO MAPPING

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

Microprocessors and Microcontrollers

Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BEBC16 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To disseminate the fundamental concepts of microprocessor and microcontroller architectures.

CLO2: To describe the interfacing of memory and peripheral devices with microprocessor and microcontroller.

UNIT - I Introduction to Microprocessor **9**

Introduction to microprocessor - Register Organization – Architecture of 8086 – Memory segmentation – Memory Banking – Pin Diagram of 8086 –Instruction set.

UNIT - II Peripherals and their Interfacing with 8086 **9**

Programmable peripheral Interface 8255 – Interfacing of ADC 0809 and DAC 0808 using 8255 – The matrix keyboard and seven segment display interfacing using 8255 – Stepper motor Interface – Programmable interval timer 8254.

UNIT - III ARM Processor Architecture **9**

ARM Architecture-ARM programmer's model - ARM development tools. Pipelining -3-stage pipeline ARM organization, 5-stage pipeline ARM organization. ARM instruction execution, ARM Instruction Set.

UNIT - IV 8051 Instruction Set and Assembly Language Programming **9**

8051 Architecture – 8051 Memory organization – Structure of internal ROM and RAM – 8051 registers – Addressing modes – 8051 instruction set – 8051 Timer section and programming – Serial port programming – 8051 I/O programming-Interrupts.

UNIT - V Interfacing Microcontrollers **9**

Seven segment display interfaces – Keyboard interfacing –ADC Interfacing – DAC interfacing –DC Motor -Stepper motor interfacing and applications.

Total Hours: **45**

References:

1. Cheng-Yu Liu, & Gibson, G. A. (2007). *Microcomputer systems: the 8086/8088 family: architecture, programming, and design.* Prentice Hall India.
2. Mazidi. (2007). *The 8051 Microcontroller And Embedded Systems Using Assembly And C, 2/E*. Pearson Education India.
3. Hall, D. V. (2012). *Microprocessors and interfacing: programming and hardware*. Tata Mcgraw Hill Education Private Ltd.
4. Hohl, W., & Hinds, C. (2015). *ARM assembly language: fundamentals and techniques.* CRC Press, Taylor & Francis Group.
5. Kant, K. (2014). *Microprocessors and microcontrollers*. Prentice-Hall Of India.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Illustrate the Architecture and Memory segmentation of 8086 Microprocessor.
CO2: Identify the pin configurations of interfacing IC's for the peripherals devices.
CO3: Describe the Architecture and pipeline organization of ARM processor.
CO4: Develop Assembly programs for the given problems using 8051 Instruction set.
CO5: Design circuits to implement simple embedded applications using microcontroller.

CO - PO MAPPING

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

Microprocessors and Microcontrollers Laboratory

Semester: V **Hours of Instruction/week: 3P**

Course Code: 24BEBC18 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To develop assembly level programs and practice the basic operations of the microprocessors and microcontrollers.

CLO2: To provide solid foundation on interfacing the external devices to the processor according to the user requirements to create novel products and solutions for the real time problems.

List of Experiments

1. Arithmetic, Logic and Matrix operations using 8086 microprocessor.
2. Sorting and Searching using 8086 microprocessor.
3. Arithmetic and Logic Operations with 8051 microcontroller.
4. Block data transfer between internal and external memory including overlapping blocks with 8051 microcontroller.
5. Interrupts Handling with 8051 microcontroller.
6. Stepper Motor and Speed Control of DC Motor using 8051 microcontroller.
7. Square waveform and Saw tooth waveform generation using 8051 microcontroller.
8. Keyboard and seven segment display interface using 8051 microcontroller.
9. Time delay generation using 8051 microcontroller.
10. Stepper Motor interface using 8086/8051.
11. DC Motor interface using 8086/8051.
12. Interface a simple Switch and display its status through LED using 8086.

Total Hours: **45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Implement the basic programming for Arithmetic and Logical operations in 8086 microprocessor and 8051 microcontrollers.

CO2: Interfacing of stepper motor, DC motor, Keyboard and seven segment display interface using 8051 microcontroller.

CO3: Interfacing of Stepper Motor and DC motor interfacing using 8086 Processor

CO - PO MAPPING

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

Diagnostic and Therapeutic Equipment Laboratory

Semester: V **Hours of Instruction/week: 3P**
Course Code: 24BEBC17 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To demonstrate recording and analysis of different Bio potentials.
CLO2: To examine different therapeutic modalities.

List of Experiments

1. To measure the blood pressure levels using Sphygmomanometer
2. To record the 12 channel ECG signals using Page writer
3. To record the oxygen saturation and Heart Rate using Pulse Oximeter
4. To plot the human auditory response using Digital Audiometer
5. Acquisition of heart sounds using Phonocardiograph
6. Study and analysis of functioning and safety aspects of Surgical Diathermy
7. To perform the operation of Drug Delivery Device
8. To acquire vital parameters from Real time Patient Monitoring System
9. To perform the sterilization using Autoclave.
10. To measure the dimension of blood vessels using Vascular Doppler.

Total Hours: **30**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Measure different bioelectrical signals using various methods.
CO2: Operate sphygmomanometer, phonocardiograph, audiometer and monitor the physiological parameters.
CO3: Demonstrate surgical diathermy, autoclave and drug delivery system.

CO - PO MAPPING

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

School of Engineering

Design Thinking

(Non-credit Mandatory Course)

(Applicable for the B.E. students admitted from the academic year 2024-2025 & onwards)

Semester V **Hours of Instruction/week: 1+2P**

Course Code: 24BEMC05

Course Learning Objectives (CLOs):

CLO1: To provide the new ways of creative thinking
CLO2: To learn the innovation cycle of Design Thinking process for developing innovative products.

UNIT - I An Insight to Learning **9**

Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting, Remembering Memory: Understanding the Memory process, Problems in retention, Memory enhancement techniques, Emotions: Experience and Expression: Understanding Emotions: Experience and Expression, Assessing Empathy, Application with Peers.

UNIT - II Basics of Design Thinking **9**

Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts and Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test. Being Ingenious and Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving.

UNIT - III Process of Product Design **9**

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and 15 functions, Assignment – Engineering Product Design Prototyping and Testing: What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

UNIT - IV Celebrating the Difference **9**

Understanding Individual differences and uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences. Design Thinking and Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

UNIT - V Feedback, Re-Design and Re-Create **9**

Feedback loop, Focus on user Experience, Address ergonomic challenges, user focused design, rapid prototyping and testing, final product, final Presentation, Solving Practical Engineering Problem through Innovative Product Design and Creative Solution.

Total Hours: 45

Reference Books:

1. Burgelman, R. A., Christensen, C., & Wheelwright, S. C. (2009). *Strategic Management of Technology and Innovation*. McGraw-Hill/Irwin.
2. Idris Mootee. (2013). *Design Thinking for Strategic Innovation*. John Wiley & Sons.
3. Martin, R. L. (2009). *The design of business: Why design thinking is the next competitive advantage.* Harvard Business Press.
4. Hasso Plattner, Christoph Meinel, & Leifer, L. (2015). *Design Thinking Research: Building Innovators*. Springer International Publishing.
5. Liedtka, J., King, A., & Bennett, K. (2013). *Solving Problems with Design Thinking Ten Stories of What Works.* New York; Chichester, West Sussex Columbia University Press.
6. Asmaraningtyas, L.W., Rahmawati, I.D., & Fitriyah, H. (2024). *Green Business Innovation: Sustainable Business Model Development through Integration of Business Model Canvas, Design Thinking, and Islamic Business Ethics.* Golden Ratio of Marketing and Applied Psychology of Business.

Course Outcomes:

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

- **CO1:** Compare and classify the various learning styles and memory techniques and apply them in their engineering education Discuss the characteristics of semiconductor diodes.
- **CO2:** nalyze and inspect emotional expressions in designing products.
- **CO3:** Develop new ways of creative thinking.
- **CO4:** Propose real-time innovative engineering products designs and choose appropriate frameworks, strategies, techniques during prototype development..
- **CO5:** Perceive individual differences and its impact on everyday decisions and further create a better customer experience.

CO, PO MAPPING

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

Radiology and Nuclear Medicine

Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBC19 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn the principle operation of X-ray and its uses in imaging.
CLO2: To discuss the radiation therapy techniques and radiation safety.

UNIT - I X-Ray Equipment **9**

Nature of X-rays, X-Ray absorption, Tissue contrast. Quality of X-rays, X-Ray Equipment (Block Diagram), X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography, discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes, Fluoroscopy, Digital Fluoroscopy.

UNIT - II Nuclear Medicine **9**

Basic characteristic and units of radioactivity, ionization chamber, GM tubes, Gas filled detectors, scintillation detectors, semiconductor detectors, Liquid scintillation counter, Statistical aspects of nuclear medicine.

UNIT - III Nuclear Medicine Imaging System **9**

Rectilinear scanners, Scintillation Camera, principle of operation, collimator, photomultiplier tube, Pulse height Analyzer, computerized multi crystal Gamma camera, Principles of PET and SPECT.

UNIT - IV Radiation Therapy **9**

Principles of Radiation Therapy, Radio therapy treatment planning Dose in Radiotherapy, Mega voltage therapy, Intensity modulated Radiation therapy, Brachytherapy, Radiotherapy using radio isotopes.

UNIT - V Radiobiology and Radiological Protection **9**

Radiation sensitivity of biological materials, Evidence on radiobiological damage from cell survival curve, Radiation effects on humans, Maximum permissible dose equivalent limits, Hazard from ingested radioactivity, substances, ICRP regulations, Quality factor and sievert, Principles of radiological protection, personnel dosimetry.

Total Hours: **45**

References:

1. Dendy, P. P., & Heaton, B. (2012). *Physics for diagnostic radiology*. CRC Press, Taylor & Francis Group.
2. Khan, F. M. (2012). *The Physics of Radiation Therapy*. Lippincott Williams & Wilkins.
3. Saha, G. B., & Springerlink (Online Service. (2006). *Physics and radiobiology of nuclear medicine*. Springer.
4. Allisy-Roberts, P., Williams, J. R., & Farr, R. F. (2008). *Farr's physics for medical imaging*. Saunders.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Describe the characteristics of radioactivity and working of X-ray equipment.
CO2: Illustrate the principles of nuclear medicine.
CO3: Identify the various nuclear imaging modalities
CO4: Understand the principle of radiation therapy, treatment plans and dosimetry.
CO5: Apply the principles of radiological protection and ICRP regulations.

CO - PO MAPPING

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

ICU and Operation Theatre Equipment

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BEBC20 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand and to acquire knowledge on the basic principles and working of equipment used in surgeries and extracorporeal devices used in critical care.

CLO2: To create a strong foundation in medical devices by understanding the patient safety and centralized hospital systems.

UNIT - I ICU Equipment **9**

Suction apparatus, Sterilization methods - Steam for small and larger units, Chemical, Radiation, Gaseous sterilization. Automated drug delivery systems- Drug infusion systems, components, syringe pumps, peristaltic pumps, drop rate infusion pumps, Volumetric infusion pumps, Microprocessor based infusion pump, open and closed loop control, implantable infusion systems, Programme controlled insulin dosing device.

UNIT - II Critical Care Equipment **9**

Principle of dialysis, Composition of dialysate, Diseases of the kidney, Different types of Dialyzers, Performance analysis, Membranes, Hemodialysis machine, Machine controls and measurements. Heart Lung Machine, importance of hypothermia, types of oxygenators, peristaltic pumps, Incubators and Radiant warmer.

UNIT - III Operation Theatre Equipment **9**

Principle of Surgical diathermy, Electrosurgery techniques, Solid state diathermy machine, Automated electrosurgical systems, Risks and safety aspects. Anesthesia machine-Need, Delivery of anesthesia, Gas supply and vapour delivery system, Patient breathing system and circle system.

UNIT - IV Centralized Systems **9**

Centralized medical gas system-advantages, Centralized Oxygen and Nitrous oxide, compressed Air & Vaccuum, pipes, precautions and controls, alarm system and safe handling of gases. Centralized Air Conditioning-chiller units, Operation Theatre table- special features, accessories, surgical positions, line diagrams, Surgical lighting-Dome type ceiling fixed surgical spotlight.

UNIT - V Patient Safety **9**

Physiological effects of electricity, Patient electrical safety, Electric shock hazards, Natural protective mechanisms against electricity, Leakage currents, Types, leakage current measurement, Grounding, Inspection of grounding, patient isolation-isolation transformer, Optocouplers and Pulse transformers, Grounding in operation rooms, ICCU and IMCUs.

Total Hours: **45**

References:

1. R.S. Khandpur. (2014). *Handbook of Biomedical Instrumentation*. McGraw-Hill Education.
2. Webster, J. G. (2020). *Medical instrumentation: application and design*. Wiley.
3. Kunders, G. D. (2009). *Hospitals: facilities planning and management*. Tata Mcgraw-Hill Publishing, Repr**.**
4. S.K. Venkata Ram. (2003). *Bio-Medical Electronics & Instrumentation*.
5. Carr, J. J., & John Michael Brown. (2001). *Introduction to Biomedical Equipment Technology.* Pearson.

Course Outcomes:

At the end of the course, students will be able to:

- **CO1:** Understand the basic principles and working of Infusion equipment, suction machine and sterilization methods.
- **CO2:** Understand the basic principle and working of Dialysis machine, heart lung machine, and incubators.
- **CO3:** Understand the basic principle and working of Surgical Diathermy machine and the risks involved and safety aspects to be incorporated and the operation of anesthesia machine
- **CO4:** Understand the centralized systems in a hospital, OT table and OT lights.
- **CO5:** Apply the safety aspects to be incorporated in the design of medical equipment.

CO - PO MAPPING

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

Embedded Systems and IoMT

Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBC21 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: Acquire knowledge and understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
CLO2: Understand the hardware architecture and features of embedded microcontrollers and peripherals.

UNIT - I Introduction to Embedded System Design 9

Introduction to embedded processors- Application Areas- Categories of embedded processors- Challenges in Embedded System Design, Design Process- Requirements- Specifications- Hardware architecture- Software architecture-Introduction to Harvard & Von Neuman architectures- CISC & RISC Architectures. CPU Bus- Bus Protocols- Bus Organisation, Memory Devices, and their Characteristics- RAM, EEPROM-Flash Memory- DRAM. BIOS, POST, Device Drivers

UNIT - II Peripheral Interfacing 9

I/O Devices-Timers and Counters- Watchdog Timers, Interrupt Controllers- A/D and D/A, Interfacing- Memory interfacing with a case study- I/O Device Interfacing with case Study- Programmed IO-Memory Mapped IO, Interfacing Protocols-SPI, I2C, USB, CAN, Ethernet/WiFi, Bluetooth.

UNIT - III Embedded System Software Design 9

Application Software, System Software, Design techniques – State diagrams, sequence diagrams, flowcharts, etc., Model-based system engineering (MBSE), Use of High-Level Languages embedded C / C++ Programming, Integrated Development Environment tools- Editor- Compiler- Linker- Automatic Code Generators- Debugger- Board Support Library- Chip Support Library, Analysis and Optimization-Execution Time- Energy & Power.

UNIT - IV Design and Development of IoT 9

Definition and characteristics of IoT, Technical Building blocks of IoT, Communication Technologies, Physical design of IoT - system building blocks - sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Benefits and impact of IoMT. Cybersecurity – vulnerability, penetration & encryption technologies

UNIT - V Internet of Medical Things 9

Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, A loT Model for Neuro sensors, AdaBoost with feature selection using loT for somatic mutations evaluation in Cancer, A Fuzzy-Based expert System to diagnose Alzheimer's Disease, Secured architecture for loT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments.

Total Hours: **45**

References:

1. Peckol, J. K. (2019). *Embedded systems: a contemporary design tool*. John Wiley.
2. Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J. (2017). *IoT Fundamentals*. Cisco Press.
3. P Venkata Krishna, Sasikumar Gurumoorthy, Obaidat, M. S., & Springerlink (Online Service. (2019). *Internet of Things and Personalized Healthcare Systems*. Springer Singapore.
4. V, S. K. (2009). *Introduction to embedded systems*. Tata Mcgraw-Hill Education.
5. Simon, D. E. (1999). *An embedded software primer*. Addison Wesley.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Explain fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.

CO2: Describe the hardware architecture and features of embedded microcontrollers and peripherals.

CO3: Explain software design tools and embedded system design programming phases.

CO4: Describe IoT Architectures and Build simple IoT Systems using embedded target boards.

CO5: Exhibit understanding of IoMT infrastructure for healthcare applications.

CO - PO MAPPING

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

Digital Image Processing

Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBC22 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: Be exposed to image processing fundamentals and techniques.
CLO2: Be familiar with image compression, segmentation and representation algorithms to solve image processing problems.

UNIT - I Fundamentals of Image Processing 9

Introduction – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - color models – RGB and HSI colour models.

UNIT - II Image Enhancement and Restoration 9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering.
Frequency Domain: 2D DFT – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering.
Restoration: Degradation model, Noise models, Restoration using inverse filtering and Wiener filtering.

UNIT - III Image Compression 9

Types of redundancy, Fidelity criteria, Lossless compression – Run length coding, Huffman coding, Bit-plane coding, Arithmetic coding. Introduction to DCT, Wavelet transform. Lossy compression – DCT based compression, Wavelet based compression. Image and Video Compression Standards – JPEG and MPEG.

UNIT - IV Image Segmentation 9

Image Segmentation: Point Detections, Line detection, Edge Detection - First order. Derivative – Prewitt and Sobel. Second order derivative – LoG, DoG, Canny. Edge linking, Hough Transform, Thresholding – Global, Adaptive. Otsu's Method. Watershed Segmentation.
Region Growing, Region Splitting and Merging. Morphological Operations – erosion and dilation.

UNIT - V Representation and Description 9

Representation – Chain codes, Polygonal approximation, Signatures. Boundary Descriptors – Shape numbers, Fourier Descriptors, Statistical moments. Regional Descriptors – Topological, Texture. Principal Components for Description.

Total Hours: **45**

References:

1. Gonzalez, R. C., & Woods, R. E. (2018). *Digital Image Processing* (4th ed.). Pearson.
2. Pratt, W. K. (2007). *Digital Image Processing*. Wiley-Interscience.
3. S Jayaraman, S Esakkirajan, & T Veerakumar. (2009). *Digital image processing.* Tata Mcgraw Hill Education.
4. Jain, A. K. (2006). *Fundamentals of digital image processing*. Prentice-Hall Of India.
5. Chanda, B., & Dwijesh Dutta Majumder. (2011). *Digital image processing and analysis*. New Delhi Prentice-Hall Of India.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Discuss digital image fundamentals.

CO2: Apply image enhancement and restoration techniques.

CO3: Interpret image compression techniques.

CO4: Develop algorithms for image segmentation.

CO5: Discuss image representation methods.

CO - PO MAPPING

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

Virtual Instrumentation Laboratory

Semester: VI **Hours of Instruction/week: 3P**
Course Code: 24BEBC23 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To implement Virtual Instruments using LabVIEW.
CLO2: To analyze biomedical signals using graphical programming tools.

List of Experiments

1. Getting Started with LabVIEW, Basic operations, controls and Indicators
2. Simple programming structures and Timing Issues
3. LabVIEW -Programming Structure, Sub VIs, Clusters & Traffic Light Controller
4. Multiplexer and demultiplexer using digital ICs
5. Design of Virtual Instruments like Function Generator, Oscilloscope, Spectrum analyzer
6. Data Acquisition using Virtual instrumentation from temperature Sensor
7. Communication via RS232/ Serial Port
8. Implementation of Phase Shift Oscillator using NI ELVIS
9. Integration of m files in LabVIEW
10. Computerized data logging of ECG signal and find the heart beat rate using LabVIEW.

Total Hours: **45**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Design and implement virtual instruments.
CO2: Develop the data acquisition system using analog and digital hardware.
CO3: Apply virtual instrumentation concepts for bio-signal processing.

CO - PO MAPPING

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

Digital Image Processing Laboratory

Semester: VI **Hours of Instruction/week: 3P**
Course Code: 24BEBC24 **No. of credits: 1**

Course Learning Objectives (CLOs):

CLO1: To perform the basic operations on images.
CLO2: To design and implement algorithms for the real time image processing applications.

List of Experiments

1. Point Processing techniques
2. Spatial domain Filtering
3. Histogram Processing
4. Frequency Domain Filtering (Plotting 2D-DFT, Low pass and High Pass- Ideal Butterworth and Gaussian Filters)
5. Segmentation - Gradient operators
6. Transforms - DCT and DWT
7. Image compression techniques
8. A mini project based on medical image processing

Total Hours: **30**

Course Outcomes:

At the end of the course, students will be able to:

CO1: Perform enhancing operations on the image using spatial filters and frequency domain filters.
CO2: Implement the algorithms for segmentation and compression.
CO3: Apply image processing technique to solve real health care problems.

CO - PO MAPPING

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

School of Engineering

Professional Ethics

(Non-credit Mandatory Course)

(Applicable for the B.E. students admitted from the academic year 2024-2025 & onwards)

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BEMC06

Course Learning Objectives (CLOs):

CLO1: To understand and create awareness of role of Engineers towards Human and moral values,and to identify the core values that shapes the ethical behavior of an engineer

CLO2: To create awareness on professional ethics and Human Values and to impart moral and societal values among the learners

UNIT - I Human Values **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT - II Engineering Ethics **9**

Senses of "Engineering Ethics" – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg‟s theory – Gilligan‟s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT - III Engineering as Social Experimentation **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT - IV Safety, Responsibilities and Rights **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT - V Global Issues **9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Total Hours: **45**

References:

1 Mike W. Martin and Roland Schinzinger. (2003). *Ethics in Engineering*. Tata McGraw Hill, New Delhi.

2 Govindarajan M, Natarajan S, Senthil Kumar V. S. (2004). *Engineering Ethics*. Prentice

Hall of India, New Delhi.
3 Charles B. Fleddermann (2004). *Engineering Ethics*. Pearson Prentice Hall, New Jersey.
4 Charles E. Harris, Michael S. Pritchard and Michael J. Rabins. (2009). *Engineering Ethics – Concepts and Case*s. Cengage Learning.
5 John R Boatright. (2003). *Ethics and the Conduct of Business*. Pearson Education, New Delhi.
6 World Community Service Centre. (2011). *Value Education*. Vethathiri publications,

Course Outcomes:

At the end of the course, students will be able to:

CO1: Identify the basic perception of profession, professional ethics, various moral & social issues, industrial standards, code of ethics and role of professional ethics in engineering field.

CO2: Analyze the safety and risk involved in engineering, responsibilities of an engineer for safety and risk benefit analysis.

CO3: Outline the knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.

CO4: Discuss the ethical issues related to engineering and application of ethics in society

CO5: Realize the responsibilities and rights of an engineer in the society and the role of CSR in societal empowerment

CO - PO MAPPING

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

Hospital Management

Semester: VII **Hours of Instruction/week: 3T**

Course Code: 24BEHS07 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire knowledge on hospital systems and equipment management.

CLO2: To learn and explore various information management systems and relative supportive services in hospitals.

UNIT - I Classification of Hospital Systems **9**

Classification of hospital systems-Role of Administrator-Primary Health Center. Hospital Services-Organization of Outpatient, inpatient, supportive, casualty & emergency service systems.

UNIT - II Planning of Service Departments **9**

Ancillary services-laboratory services, physiotherapy, occupational therapy, blood transfusion services, radio diagnosis, hospital pharmacy, nursing services, dietary services, transport services, communication services. Supportive Services -Electrical System- Generator standby power-Air conditioning system-Water supply and sanitary system- Firefighting equipment –Alarm system - Housekeeping and maintenance services.

UNIT - III Hospital Information Systems **9**

Hospital information system and management- Admission/Discharge records of patients, patient billing, maintenance of patients' record - Functional characteristics of HIS-Infection control in hospitals- Pest control, hospital waste management-Lighting in hospital.

UNIT - IV Clinical Engineering Systems **9**

Need for a biomedical equipment consultant - Purchase of Biomedical Equipment- Justification, planning specification, budgeting, tendering, evaluation, selection, installation, commissioning, and acceptance. Maintenance of equipment- In-house and contract, various types of contracts, PM & CM- TQM applications-Types of Biomedical equipment.

UNIT - V Overview of the International Regulatory Framework for Medical Devices **9**

Medical device regulatory and technology assessment agencies, Role of the regulatory profession and professional, Medical device lifecycle, Medical Devices, Invitro, diagnostic and active implantable medical devices directives, ASEAN medical device directives, ISO, IEC, ASTM standards for medical devices.

Total Hours: **45**

References:

1. D K Goyal R C Sharma. (2017). *Hospital administration and human resource management*.
2. Kunders, G. D. (2009). *Hospitals: facilities planning and management*. Tata Mcgraw-Hill Publishing, Repr.
3. Lele, R. D., & India). (2005). Computers in Medicine.
4. Goel, S. L., & R Kumar. (2007). *Hospital administration and management: theory and practice*. Deep & Deep Publications.
5. Theisz, V. (2015). *Medical Device Regulatory Practices*. CRC Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Categorize the role of hospital systems and services.

CO2: Describe the importance of supportive service departments.

CO3: Illustrate the significance of hospital information systems.

CO4: Distinguish the knowledge on clinical engineering systems.

CO5: Explain the engineer's role in medical device maintenance and the medical ethics followed in hospital.

CO - PO MAPPING

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

Medical Imaging Techniques

Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBC26 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To possess knowledge and skills necessary to evaluate images formed in various imaging modalities.
CLO2: To acquire the ability to differentiate between the techniques and instrumentation of ionizing and non-ionizing imaging modalities and demonstrate critical thinking skills.

UNIT - I Radiographic Imaging **9**

Point spread, Line spread and Modulation Transfer Function. Beer Lamberts law for projection of radiography, Details of radio graphics and fluoroscopic images in X-ray systems, Screen, film and image intensifier systems, Picture Storage and archiving systems in Medical imaging, Digital Radiography, Principles of Digital Subtraction Angiography.

UNIT - II X-Ray Computed Tomography **9**

Basic principle, Evolution of CT machines, Acquisition, Processing, Reconstruction, Viewing and storage systems. Gantry Geometry, Patient dose in CT scanner.

UNIT - III Optical Coherence Tomography and Thermal Imaging **9**

OCT- Working Principle of OCT, Time Domain OCT, Fourier Domain OCT, OCT Angiography, Applications. .
Thermography - Introduction to thermography, Principle of Infrared Camera, Applications

UNIT - IV Ultrasonic Imaging System **9**

Diagnostic Ultrasound, Physics of Ultrasonic waves, Principles of A-Mode, B-Mode, M-Mode, Real time Ultrasonic (B-Scan) imaging systems, Requirements, Multi-element Linear array scanners, Digital scan converters, Biological effects of Ultrasound and its requirements.

UNIT - V Magnetic Resonance Imaging System **9**

Principles of NMR imaging system, Image acquisition in MRI, T1, T2, Proton density weighted images, Artifacts in imaging, Pulse sequences, conventional, fast acquisition, image reconstruction techniques, Basic NMR components, Biological effects of MRI and Advantages.

Total Hours: **45**

References:

1. R.S. Khandpur. (2014). *Handbook of Biomedical Instrumentation*. McGraw-Hill Education.
2. Michael Vollmer, Klaus-Peter Möllmann.(2017). *Infrared Thermal Imaging: Fundamentals, Research and Applications.* Wiley.
3. Ball, J. L., D Noreen Chesney, & Price, T. (2019). *Chesneys' radiographic imaging.* Blackwell Science.
4. Allisy-Roberts, P., Williams, J. R., & Farr, R. F. (2008). *Farr's physics for medical imaging*. Saunders.
5. Webb, S. (1988). *The Physics of Medical Imaging*. CRC Press.
6. Andreas Maier · Stefan Steidl, Vincent Christlein, Joachim Hornegger. (2018). *Medical Imaging Systems*. Springer.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the fundamentals of image quality, physics and instrumentation of X-ray systems.

CO2: Knowledge of principles, instrumentation and reconstruction techniques in CT

CO3: Understand the physics, instrumentation and equipment used in Nuclear medical Imaging systems.

CO4: Understand the principle of Ultrasonic imaging, the imaging equipment and biological effects.

CO5: Understand the principle and instrumentation of magnetic resonance imaging, develop the ability to operate the imaging system and apply reconstruction techniques.

CO - PO MAPPING

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

Hospital Internship

Semester: VII **Hours of Instruction/week: 4P**
Course Code: 24BEBC27 **No. of credits: 2**

Course Learning Objectives (CLOs):

CLO1: To acquire skills with respect to diagnosis and assessment of the diseases.
CLO2: To learn the professional ethical issues followed in hospital.

15 days of internship at multi-specialty hospitals

Total Hours: **60**

Course Outcomes:

At the end of the course, students will be able to:

- **CO1:** State the ethics followed in hospitals.
- **CO2:** Develop the technical and professional skills required for hospital environment.
- **CO3:** Study and analyze the infection control and safety management in hospitals and practice in servicing of equipment.

CO - PO MAPPING

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

School of Engineering

Disaster Management

(Non-credit Mandatory Course)

(Applicable for the B.E. students admitted from the academic year 2024-2025 & onwards)

Semester: VII **Hours of Instruction/week: 3T**

Course Code: 24BEMC07

Course Learning Objective (CLOs):

CLO1: To enable the students to create an awareness on Disasters and its types,

CLO 2: To study the risk management and development policies implemented by the government to protect from disaster.

UNIT - I Introduction to Disasters **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc. - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT - II Approaches to Disaster Risk Reduction (DRR) **9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- non-structural measures, Roles and responsibilities of-community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level-State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT - III Inter-Relationship between Disasters and Development **9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT - IV Disaster Risk Management in India **9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, and Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT - V Disaster Management: Applications and Case Studies and Field Works **9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

Total Hours: **45**

References:

1 Ghosh G.K. (2011). *Disaster Management*. APH Publishing Corporation.

2 Singhal J.P. (2019). *Disaster Management*. Laxmi Publications.

3 Tushar Bhattacharya. (2017). *Disaster Science and Management.* McGraw Hill India Education Pvt. Ltd.,

4 Gupta Anil K & Sreeja S. Nair. (2011). *Environmental Knowledge for Disaster Risk Management.* NIDM, New Delhi.

5 Anu Kapur. (2010). *Vulnerable* India: A Geographical Study of Disasters. IIAS and Sage Publishers, New Delhi.

6 *Govt. of India: Disaster Management Act*, Government of India, New Delhi, 2005.

7 *Government of India*, National Disaster Management Policy, 2009.

8 http://ndma.gov.in/ (Home page of National Disaster Management Authority)

Course Outcomes:

At the end of the course, students will be able to:

CO1: Discuss the basics of disasters, types and their impacts.

CO2: Explain about the Disaster Risk Reduction strategies and policies

CO3: Familiarize with the relationship between disasters and development.

CO4: Describe the disaster risk management policies and acts implemented in India.

CO5: Summarize case studies related to various disasters.

CO - PO MAPPING

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

Human Assist Devices

PE1 - Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BEBE01 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study the role and importance of machines that takes over the functions of the heart and lungs.

CLO2: To study various mechanical techniques that helps a non-functioning heart and clearance of urea from the blood.

UNIT - I Heart Lung Machine and Artificial Heart **9**

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

UNIT - II Cardiac Assist Devices **9**

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra-Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.

UNIT - III Artificial Kidney **9**

Indication and Principle of Hemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT - IV Respiratory and Hearing Aids **9**

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.

UNIT - V Recent Trends **9**

Functional Electrical Stimulation, Transcutaneous electrical nerve stimulator, bio-feedback, Haptic Devices, IoT based assist devices – Case Studies.

Total Hours: **45**

References:

1. Kolff W.J, “Artificial Organs”, John Wiley and Sons, New York, 1979
2. Andreas.F.Vonracum,“Hand book of biomaterial evalution”,Mc-MillanPublishers, 1980.
3. Albert M.Cook, Webster J.G., “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982.
4. Muzumdar A., “Powered Upper Limb Prostheses: Control, Implementation and Clinical Application, “Springer, 2004
5. Rory A Cooper, “An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC Press, UK. 2006.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Explain the functioning of heart lung machine, oxygenators and pumps.

CO2: Explain how Cardiac Assist Devices are assisted through respiration.

CO3: Describe the operation of various types of hemodialyzers.

CO4: Evaluate the effectiveness of wearable devices for hearing correction.

CO5: Apply biofeedback techniques in healthcare.

CO - PO MAPPING

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

Medical Optics

PE1 - Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBE02 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study about the optical properties of the tissues and the principle behind the photonics
CLO2: To understand and employ the applications of laser in diagnosis and therapy.

UNIT - I Optical Properties **9**

Refraction, Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical- Thermal-Electromechanical, Photo ablative processes.

UNIT - II Optical Instrumentation **9**

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

UNIT - III Optical Biosensors **9**

Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance - Advantages and disadvantages - Applications

UNIT - IV Applications of Lasers **9**

Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photoacoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyperspectral imaging.
Surgical - Lasers in dentistry, Dermatology, Ophthalmology

UNIT - V Laser Tissue Interaction **9**

Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.

Total Hours: **45**

References:

1. Vo-Dinh, T. (2014). *Biomedical Photonics Handbook*. CRC Press.
2. Jurgen Popp. (2012). *Handbook of biophotonics. Vol. 2, Photonics for health care*. Wiley-Vch.
3. Markolf Niemz. (2013). *Laser-Tissue Interactions*. Springer Science & Business Media.
4. Splinter, R., & Hooper, B. A. (2007). *An introduction to biomedical optics*. Taylor & Francis.
5. Brezinski, M. E. (2006). *Optical coherence tomography: principles and applications*. Elsevier.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Explain the various physical properties of light and optical properties of tissues.
CO2: Consolidate the working principles of optical components.
CO3: Discuss the various applications of biosensors in medicine.
CO4: Summarize the diagnostic and surgical applications of lasers in medicine.
CO5: Explain the laser tissue interaction and various therapeutic applications of lasers.

CO - PO MAPPING

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

Brain Computer Interface

PE1 - Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BEBE03 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the basic concepts of brain computer interface.

CLO2: To study the various signal acquisition and signal processing methods used in BCI.

UNIT - I Introduction to BCI **9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

UNIT - II Electrophysiological Sources **9**

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

UNIT - III Feature Extraction Methods **9**

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR, MA,ARMA models – PCA – Linear and Non-Linear Features.

UNIT - IV Feature Translation Methods **9**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT - V Applications of BCI **9**

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

Total Hours: **45**

References:

1. Bernhard Graimann, Allison, B. Z., & Gert Pfurtscheller. (2010). *Brain-Computer Interface*s. Springer Science & Business Media.
2. Rainer Spehlmann. (1990). *EEG primer*. Elsevier.
3. Cohen, A. (2019). *Biomedical Signal Processing*. CRC Press.
4. Bishop, C. M. (2002). *Neural networks for pattern recognition*. Oxford University Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Describe BCI system and its potential applications.
CO2: Analyze event related potentials and sensory motor rhythms.
CO3: Compute features suitable for BCI.
CO4: Design classifier for a BCI system.
CO5: Implement BCI for various applications.

CO - PO MAPPING

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

Rehabilitation Engineering

PE1 - Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BEBE04 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the technology used to improve the quality of life of individuals with disabilities.

CLO2: To design the wheel chair, sensory rehabilitation aid and motor rehabilitation aid.

UNIT - I Introduction to Rehabilitation **9**

Definition – Concept of Rehabilitation: Types of Physical Impairments, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering - Key Engineering Principles– Key Ergonomic Principles– Engineering Concepts in Sensory & Motor rehabilitation.

UNIT - II Engineering Concepts in Sensory Augmentation and Substitution **9**

Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution.

UNIT - III Orthopedic Prosthetics and Orthotics **9**

Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

UNIT - IV Virtual Reality **9**

Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT - V Rehabilitation Medicine and Advocacy **9**

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.

Total Hours: **45**

References:

1. Bronzino, J. D., & Peterson, D. R. (2018). *The Biomedical Engineering Handbook*. CRC Press.
2. Cooper, R. A., Ohnabe, H., & Hobson, D. A. (2005). *An introduction to rehabilitation engineering*. Taylor & Francis.
3. Teodorescu, H.-N. L., & Jain, L. C. (2006). *Intelligent Systems and Technologies in Rehabilitation Engineering*. CRC Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Summarize the key terminologies used by the rehabilitation team.
CO2: Illustrate Engineering Concepts in Sensory & Motor rehabilitation.
CO3: Design different orthotics and prosthetics for rehabilitation applications.
CO4: Summarize the need of virtual reality tools for different aids.
CO5: Appraise the legal aspects for building rehabilitation aids for the needed people.

CO - PO MAPPING

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

Speech Processing

PE2 - Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBE21 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire knowledge on speech analysis and different speech modeling procedures.
CLO2: To be familiarize with speech Recognition and Speech Synthesis Methods and its application.

UNIT - I Basic Concepts **9**

Speech Fundamentals: Articulatory Phonetics, Production and Classification of Speech Sounds; Acoustic Phonetics, Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT - II Speech Analysis **9**

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures, mathematical and perceptual, Log, Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization, Dynamic Time Warping, Multiple Time, Alignment Paths.

UNIT - III Speech Modeling **9**

Hidden Markov Models: Markov Processes, HMMs, Evaluation, Optimal State Sequence, Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT - IV Speech Recognition **9**

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system, acoustics and language models, n-grams, context dependent sub-word units; Applications and present status.

UNIT - V Speech Synthesis **9**

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness, role of prosody, Applications and present status.

Total Hours: **45**

References:

1. Rabiner, L. R., & Biing-Hwang Juang. (2005). Fundamentals of speech recognition. Delhi Pearson Education.
2. Jurafsky, D., & Martin, J. H. (2009). *Speech and language processing : an introduction to natural language processing, computational linguistics, and speech recognition*. Pearson Prentice Hall.
3. Quatieri, T. F. (2008). *Discrete-Time Speech Signal Processing*. Pearson Education.
4. Becchetti, C., & Lucio Prina Ricotti. (2008). *Speech Recognition*. John Wiley & Sons.
5. Gold, B. (2006). *Speech and audio signal processing: processing and perception of speech and music*. John Wiley & Sons.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Describe the concept of speech production mechanism and speech signal processing.

CO2: Design algorithms for extracting parameters from the speech signal and implement speech modeling techniques.

CO3: Analyze the different speech modeling techniques.

CO4: Describe the various speech recognition methods.

CO5: Discuss simple pattern recognition applications of speech processing and reproduce the concepts of speech synthesis and its applications.

CO - PO MAPPING

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

Biostatistics

PE2 - Semester: V **Hours of Instruction/week: 3T**

Course Code: 24BEBE22 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To introduce the techniques used in statistical & regression analysis.

CLO2: To compare the various parameters used in statistical significance.

UNIT - I Introduction **9**

Biostatistics - Statistical problems in Biomedical research– Basic concepts: Population, Samples and Variables - Basic probability, likelihood & odds, distribution variability.

UNIT - II Statistical Parameters **9**

Statistical parameters p-values, computation and level chi square test and distribution.

UNIT - III Regression Analysis **9**

Regression – Linear regression – Multiple linear regression – Multiple colinearity, Determining Best regression – Nonlinear regression – Logistic regression – Poison regression.

UNIT - IV Interpreting Data **9**

Life table: Interpreting life tables clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.

UNIT - V Meta Analysis **9**

META analysis for research activities, purpose and reading of META analysis, Forest graph, Funnel plots, Radial plots, L'Abbe plots, Criticisms of Meta-analysis.

Total Hours: **45**

References:

1. Fienberg, S. E., Hoaglin, D. C., Kruskal, W. H., & Tanur, J. M. (2012). *A Statistical Model.* Springer Science & Business Media.
2. Gerald van Belle, Fisher, L. D., Heagerty, P. J., & Lumley, T. (2004). *Biostatistics*. John Wiley & Sons.
3. Hoffman, J. I. E. (2019). *Biostatistics for Medical and Biomedical Practitioners*. Elsevier Science & Technology.
4. Jekel, J. F. (2014). *Epidemiology, biostatistics, and preventive medicine*. Saunders/Elsevier.
5. Merrill, R. M. (2021). *Fundamentals of Epidemiology & Biostatistics*.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Classify common statistical tests and tools.

CO2: Distinguish between p-values and confidence intervals as measures of statistical significance.

CO3: Interpret commonly used regression analysis and explain the data tables and its interpretations in community health.

CO4: Evaluate commonly used statistical and epidemiologic measures.

CO5: Analyze the various techniques in META analysis

CO - PO MAPPING

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

Biometric Systems

PE2 - Semester: V **Hours of Instruction/week: 3T**
Course Code: 24BEBE23 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the technologies and general principles of biometric systems.
CLO2: To gain knowledge about personal privacy and security implications of biometrics-based identification technology.

UNIT - I Introduction to Biometrics **9**

Introduction and back ground, biometric technologies, passive biometrics, active biometrics, Biometric characteristics, Biometric applications, Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non-match rate- Failure to enroll rate- Derived Metrics-Biometrics and Privacy.

UNIT - II Fingerprint Technology **9**

History of finger print pattern recognition-General description of finger prints-finger print sensors, finger print enhancement, Feature Extraction- Ridge orientation, ridge frequency, finger print matching techniques- correlation based, Minutiae based, Ridge feature based, finger print classification, Applications of finger prints, Finger scan- strengths and weaknesses, Evaluation of fingerprint verification algorithms.

UNIT - III Face Recognition and Hand Geometry **9**

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model-based face recognition in video images, Neural networks for face recognition, Hand geometry, scanning, Feature Extraction, classification.

UNIT - IV Iris Recognition **9**

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization- Daugman and Wilde‘s approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.

UNIT - V Voice Scan and Multimodal Biometrics **9**

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system, Integration strategies, Architecture, level of fusion, combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction, matching location, local host - authentication server, match on card (MOC).

Total Hours: **45**

References:

1. Kung, S.Y., Mak, M., & Lin, S.H. (2004). *Biometric Authentication: A Machine Learning Approach.*
2. Ross, A. A., Karthik Nandakumar, & Jain, A. K. (2006). *Handbook of Multibiometrics*. Springer Science & Business Media.
3. Wayman, J., Anil Jain, Maio, D., & Davide Maltoni. (2005). *Biometric Systems Technology, Design and Performance Evaluation*. London Springer-Verlag London Limited.

4. Reid, P. (2003*). Biometrics and Network security*. Prentice Hall Ptr.
5. Nalini Ratha, & Ruud Bolle. (2006). *Automatic Fingerprint Recognition Systems*. Springer.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Demonstrate the principles of biometric systems.
CO2: Develop fingerprint recognition technique.
CO3: Design face recognition and hand geometry system.
CO4: Design iris recognition system.
CO5: Develop speech recognition and multimodal biometric systems.

CO - PO MAPPING

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

Biosignal Processing

PE2 - Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE24 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the concepts of biosignals and time series analysis.
CLO2: To acquire knowledge about filtering techniques, biosignal classification and recognition.

UNIT - I Bio signal and Spectral Characteristics 9

Characteristics of some dynamic biomedical signals, Noises - random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum, power spectral density function, cross-spectral density and coherence function, Cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT - II Time Series Analysis and Spectral Estimation 9

Time series analysis, linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model-based ECG simulator. Spectral estimation, Blackman Tukey method, periodogram and model-based estimation. Application in Heart rate variability, PCG signals.

UNIT - III Adaptive Filtering and Wavelet Detection 9

Filtering, LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG, structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT - IV Biosignal Classification and Recognition 9

Signal classification and recognition, Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network-based classification. Application in Normal versus Ectopic ECG beats.

UNIT - V Time Frequency and Multivariate Analysis 9

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

Total Hours: **45**

References:

1. ***Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach***", Wiley- Interscience/IEEE Press, 2002.
2. ***Willis J. Tompkins, "Biomedical Digital Signal Processing"***, Prentice Hall of India,

New Delhi, 2003.

3. ***Raghuveer M. Rao and Ajith S. Bopardikar, "Wavelets Transform, Introduction to theory and its applications"***, Pearson Education, India 2000.
4. ***D.C.Reddy, "Biomedical Signal Processing, Principles and Techniques***", TMH, New Delhi, 2005.
5. ***GariD. Clifford, Francisco Azuaje and Patrick E.McSharry, "Advanced Methods and Tech for ECG Data Analysis",*** *ARTECH House, Boston,2006.*

Course Outcomes:

At the end of the course, students will be able to:

CO1: Preprocess the Biosignals.

CO2: Analyze biosignals in time domain and to estimate the spectrum.

CO3: Apply wavelet detection techniques for biosignal processing.

CO4: Classify biosignals using neural networks and statistical classifiers.

CO5: Extract the features using multivariate component analysis.

CO - PO MAPPING

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

Medical Device Regulations

PE1 - Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE05 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the medical device classes and regulatory efforts and to familiarize the national and international medical device regulations and standards.
CLO2: To know about the patents and intellectual property rights.

UNIT - I Definition of Testing **9**

Parsing test requirements, test protocol, test methodology, purpose of the test, failure definition, determining sample size and test length, types of testing. Analysis of test data- failure rate, mean time between failure, reliability, confidence level, confidence limits, minimum life, graphical analysis. Reliability and liability- negligence, strict liability, breach of warranty, defects, plaintiff's conduct, defendant's conduct, defendant related issues, manufacturers and physicians responsibilities, accident reconstruction and forensics.

UNIT - II Food and Drug Administration **9**

History of device regulation, device classification, registration and listing, 510(k) process, declaration of conformance to a recognized standard, PMA application, investigational device exemptions, good laboratory practices, good manufacturing practices, human factors, design control, FDA and software classification, FDA inspection, advice on dealing with the FDA regulations and standards- definition of medical device, MDD, United States Domestic Standards, rest of the world standards.

UNIT - III Indian Medical Device Rules and Regulations **9**

Indian medical device rules and regulations-2017, licensing patents, copyrights and trade secrets, trademarks. Manufacturing and quality control- GMP regulations, design for manufacturability, design for assembly, manufacturing process.

UNIT - IV Miscellaneous Issues **9**

Learning from failure, design for failure, design for convenience, universal design, design for assembly, prevention through design, design for the environment, poka-yoke, product life issues, product testing issues. Product safety and legal issues, accident reconstruction and forensics, biomechanics and traffic-accident investigations. professional issues, BME – related professional societies, standards setting groups, professional engineering licensure, rules of professional conduct, codes of ethics, forensics and consulting, continuing education.

UNIT - V Design of Case studies **9**

Multidetector brain scanning system development, testing of anesthetists, apnea detection system, cancer clinic charting, EKG analysis techniques & module.

Total Hours: **45**

References:

1. Ramakrishna, S., Tian, L., Wang, C., Liao, S., & Teo, W. E. (2015). *Medical devices: regulations, standards and practices.* Woodhead Publishing, an imprint of Elsevier.
2. Theisz, V. (2016). *Medical Device Regulatory Practices*. CRC Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the basic concepts of medical device regulations and define the purpose and types of testing.

CO2: Discuss the FDA regulations and standards, and global policies on medical device regulations.

CO3: Inspect and investigate national and international device regulation standards.

CO4: Discuss the various regulatory and safety issues in designing of medical equipment.

CO5: Analyze the way design concepts are imbibed in practical scenarios.

CO - PO MAPPING

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

Artificial Organs and Implants

PE1 - Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE06 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the medical device classes and regulatory efforts and to familiarize the national and international medical device regulations and standards.
CLO2: To know about the patents and intellectual property rights.

UNIT - I Artificial Organs & Transplants **9**

Artificial Organs:-Introduction, outlook for organ replacements, design consideration, evaluation process.
Transplants:-Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

UNIT - II Principles of Implant Design **9**

Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.

UNIT - III Implant Design Parameters and its Solution **9**

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.

UNIT - IV Blood Interfacing Implants **9**

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

UNIT - V Implantable Medical Devices and Organs **9**

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

Total Hours: **45**

References:

1. Kopff W.J, *Artificial Organs*, John Wiley and sons, New York, 1st edition, 1976
2. Bronzino, J. D. (2000). *The biomedical engineering handbook*. CRC Press.
3. Khandpur, R. S. (2014). *Handbook of Biomedical Instrumentation*, Second Edition. Tata McGraw-Hill Education.
4. Yannas, I. V. (2001). *Tissue and organ regeneration in adults*. Springer.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Gain adequate knowledge about artificial organs & transplants
CO2: Get clear idea about implant design and its parameters and solution
CO3: Have in-depth knowledge about blood interfacing implants
CO4: Explain different types of soft tissue replacement and hard tissue replacement
CO5: Assess compatibility and functioning of artificial organs inside the living system.

CO - PO MAPPING

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

BioMEMS and Nanotechnology

PE1 - Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE07 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To gain knowledge on the principles and fabrication techniques of BioMEMS.
CLO2: To acquire knowledge on applications of MEMS and Nanotechnology in Medicine.

UNIT - I Introduction to MEMS & Nanotechnology 9

Introduction to BioMEMS and Nanotechnology, Development of MEMS technology- Comparison of microsystems and microelectronics – Materials for MEMS-Smart Materials and Structures – Applications of MEMS.

UNIT - II Micro and Nanofabrication Techniques 9

Nanotechnology, Bottom up and top down methods of synthesis - Self-assembly- lithography techniques, etching – Ion implantation, surface micromachining - LIGA process - CVD technique.

UNIT - III MEMS Sensors and Actuators 9

Sensing and Actuation – Piezo resistive and Capacitive sensing - Electrostatic actuation - Pressure sensors - Accelerometers, Gyroscopes - Interfacing with Sensors and Actuators- Nanopore sensors – magnetic sensors, Thermal sensors and actuators.

UNIT - IV Micro-Opto Electromechanical Systems & Microfluidics 9

Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter, Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors - Important Consideration on Micro-scale fluid, Properties of fluid - Fluid Actuation Methods, Micro- pumps - Typical Micro-fluidic Channel, Micro-fluid Dispenser.

UNIT - V Applications of MEMS and Nanotechnology in Medicine 9

Biochip - Micro Total Analysis Systems detection and measurement methods - DNA sensor - Drug delivery system, Ampero-metric Biosensor - Multi-analyte measurement, Micro-dialysis - Monitoring of Glucose & Lactate with a micro-dialysis probe, Ammonia Monitoring - Electronic Nose, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano-devices in biomedical applications.

Total Hours: **45**

References:

1. Saliterman, S. S. (2006). *Fundamentals of bioMEMS and medical microdevices.*
2. Ferrari, M., Desai, T.A., & Bhatia, S.N. (2007). *Comprar BioMEMS and Biomedical Nanotechnology · Volume III: Therapeutic Micro/Nanotechnology* | Ferrari, Mauro | 9780387255651 | Springer.
3. Hsu, T. (2001). *MEMS and Microsystems: Design and Manufacture*.
4. Senturia, S.D. (2000). *Microsystem Design*. Springer, New Delhi.
5. Liu, C. (2006). *Foundations of MEMS*, Pearson Education International, New Jersey, USA.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Summarize the various MEMS fabrication techniques and fundamentals of nanotechnology.

CO2: Discuss the micro and nano fabrication techniques.

CO3: Elucidate the different types of electrostatic and piezoelectric sensors and actuators and their principles of operation at the micro scale level.

CO4: Explain the microfluidic systems.

CO5: Discuss about the recent applications of MEMS and nanotechnology in medicine.

CO - PO MAPPING

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

Electromagnetic Interference and Compatibility

PE1- Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE08 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To introduce the basic concepts of Electromagnetic Interference.
CLO2: To teach the importance of Electromagnetic Compatible designs.

UNIT - I Basic Concepts **9**

Definition of EMI and EMC; Intra and Inter system EMI; Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility; Transient & ESD; Case Histories; Radiation Hazards to humans.

UNIT - II Coupling Mechanism **9**

Common made coupling; Differential mode coupling; Common impedance coupling; Ground loop coupling; Field to cable coupling; Cable to cable coupling; Power mains and Power supply coupling.

UNIT - III EMI Mitigation Techniques **9**

Shielding – principle, choice of materials for H, E and free space fields, and thickness; EMI gaskets; Bonding; Grounding – circuits, system and cable grounding; Filtering; Transient EMI control devices and applications; PCB Zoning, Component selection, mounting, trace routing.

UNIT - IV Standards and Regulation **9**

Units of EMI; National and International EMI Standardizing Organizations – IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.

UNIT - V Test Methods and Instrumentation **9**

EMI test sites - Open area site; TEM cell; Shielded chamber; Shielded Anechoic chamber; EMI test receivers; Spectrum Analyzer; Transient EMI Test wave Simulators; EMI coupling Networks - Line impedance Stabilization Networks; Feed through capacitors; Antennas and factors; Current probes and calibration factor; MIL-STD test methods; Civilian STD Test methods, Government policies.

Total Hours: **45**

References:

1. V. Prasad Kodali. (2001). *Engineering Electromagnetic Compatibility*. Wiley-IEEE Press.
2. Ott, H. W. (1988). *Noise Reduction Techniques in Electronic Systems*. Wiley-Interscience.
3. Don R.J.White (1988). Consultant Incorporate, *Handbook of EMI/EMC*, Vol I-V
4. Keiser, B. (1987). *Principles of Electromagnetic Compatibility*. Artech House Microwave Library.
5. Paul, C. R., Scully, R. C., & Steffka, M. A. (2022). *Introduction to Electromagnetic Compatibility*. John Wiley & Sons.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand the operation of electromagnetic waves and their responses and effects.

CO2: Describe the functions of a ground, understanding about cables and connectors to design using the same.

CO3: Explain the EMI Sources, EMI problems in PCB level / Subsystem and system level design.

CO4: Illustrate the emission immunity level from different systems to couple with the prescribed EMC standards

CO5: Understand the different types of EMI/EMC measurement techniques and measuring equipment.

CO - PO MAPPING

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

Medical Informatics

PE2 - Semester: VI **Hours of Instruction/week: 3T**
Course Code: 24BEBE25 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To study the applications of information technology in health care management.
CLO2: To gain knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

UNIT - I Medical Informatics **9**

Introduction, Medical Informatics, Bioinformatics, Health Informatics, Structure of Medical Informatics Functional capabilities of Hospital Information System, On-line services and off, line services, History taking by computer, Dialogue with the computer

UNIT - II 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.

UNIT - III Medical Data Storage and Automation **9**

Plug in Data Acquisition and Control Boards, Data Acquisition using Serial Interface, Medical Data formats, Signal, Image and Video Formats, Medical Databases, Automation in clinical laboratories, Intelligent Laboratory Information System, PACS, Data mining.

UNIT - IV Health Informatics **9**

Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training.

UNIT - V Recent Trends in Medical Informatics **9**

Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment, Surgical simulation, Radiation therapy and planning, Telemedicine, virtual Hospitals, Smart Medical Homes, Personalized e-health services, Biometrics, GRID and Cloud Computing in Medicine.

Total Hours: **45**

References:

1. Lele, R. D. (2005). *Computers in medicine: progress in medical informatics*. Tata Mcgraw-Hill.
2. Bansal, M. (2003). *Medical informatics: a primer*. Tata Mcgraw-Hill Pub. Co.
3. N Mathivanan. (2007). *PC-based instrumentation: concepts and practice*. Prentice-Hall Of India.
4. Orpita Bosu, & Simminder Kaur Thukral. (2007). *Bioinformatics.* Oxford University Press, USA.
5. Yi-Ping Phoebe Chen. (2007). *Bioinformatics Technologies*. Springer Science & Business Media.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Explain the structure and functional capabilities of Hospital Information System.
CO2: Discuss the various medical standards.
CO3: Describe the need of computers in medical imaging and automated clinical laboratory.
CO4: Compare the different health informatics fields.
CO5: Discuss the application of virtual reality and telehealth technology in medical industry.

CO - PO MAPPING

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

Artificial Intelligence and Machine Learning

Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BEBE26 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To introduce Machine Learning and supervised learning algorithms.

CLO2: To study about ensembling and unsupervised learning algorithms.

UNIT - I Problem Solving **9**

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

UNIT - II Probabilistic Reasoning **9**

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT - III Supervised Learning **9**

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.

UNIT - IV Ensemble Techniques and Unsupervised Learning **9**

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT - V Neural Networks **9**

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

Total Hours: **45**

References:

1 Russell, S. J., & Norvig, P. (2021). *Artificial intelligence: a modern approach*. Pearson India Education Services Pvt. Ltd.

2 Alpaydin, E. (2020). *Introduction to machine learning*. The Mit Press.

3 Patterson, D. W. (2008). *Introduction to artificial intelligence and expert systems*. PHI Learning.

4 Rich, E., & Knight, K. (2008). *Artificial intelligence*. Mcgraw-Hill.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Use appropriate search algorithms for problem solving

CO2: Apply reasoning under uncertainty

CO3: Build supervised learning models

CO4: Build ensembling and unsupervised models

CO5: Build deep learning neural network models

CO - PO MAPPING

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

Body Area Networks

PE2- Semester: VI **Hours of Instruction/week: 3T**

Course Code: 24BEBE27 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To acquire knowledge about Body Area Networks (BAN) and different hardware related to it.

CLO2: To understand the communication and security aspects in the BAN.

UNIT - I Introduction **9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture.

UNIT - II Hardware for BAN **9**

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT - III Wireless Communication and Network **9**

RF communication in Body, Antenna design and testing, Propagation, Base Station- Network Topology-Stand, Alone BAN, Wireless personal Area Network Technologies- IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zigbee.

UNIT - IV Coexistence Issues with BAN **9**

Interferences, Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues -Medical Device regulation in USA and Asia, Security and Self-protection Bacterial attacks, Virus infection, Secured protocols, Self- protection.

UNIT - V Applications of BAN **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

Total Hours: **45**

References:

1. Bonfiglio, A., & Danilo De Rossi. (2014). *Wearable Monitoring Systems*. Springer Science & Business Media.
2. Sandeep K S Gupta, Tridib Mukherjee, & Krishna Kumar Venkatasubramanian. (2013). *Body area networks: safety, security, and sustainability*. Cambridge University Press.
3. Zhang, Y.-T. (2016). *Wearable Medical Sensors and Systems*. Springer.
4. Yang, G.-Z. (2014). *Body Sensor Networks*. London Springer.
5. Mehmet Rasit Yuce, & Khan, J. Y. (2012). *Wireless body area networks: technology, implementation, and applications*. Pan Stanford Pub.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Comprehend the significance and role of BAN in healthcare.
CO2: Define the hardware architecture for designing BAN.
CO3: Describe the wireless communication technologies.
CO4: Discuss the regulatory issues and protocols for secured transmission.
CO5: Extend the concepts of BAN for medical applications.

CO - PO MAPPING

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

Medical Data Analytics

PE2- Semester VI **Hours of Instruction/week: 3T**

Course Code: 24BEBE28 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn about data analytics and different statistical tools related to medical data applications.

CLO2: To understand and apply the algorithms in health care applications.

UNIT I Introduction to Healthcare Data **9**

Typical problems of data analysis, descriptive statistics, predictive modeling, health surveys - measure of disease risk and association, standardization of data - Introduction to spreadsheet - importing, coding and manipulating data, writing formulas and linking tables, pivot tables, what-if analysis and data displays.

UNIT II Introduction to Statistical Learning **9**

Probability - Bayes Rule - types of distributions - estimation of unknown function, prediction accuracy and model interpretability, supervised versus unsupervised learning, regression versus classification, modeling data, principles of guesstimation.

UNIT III Algorithms for Regression **9**

Linear regression, ridge regression, the lasso, logistic regression, linear discriminant analysis- case studies.

UNIT IV Algorithms for Classification **9**

K-nearest neighbors - splines - generalized additive models, tree-based methods - support vector machines, Random forests, case studies.

UNIT V Computational Tools **9**

Introduction to R Package: Basic commands, Graphics, indexing data, loading data, time series analysis, graphical multivariate analysis - analytics in clinical trials- predicting the medical devices life cycle- predicting deterioration of patient's condition using EMR.

Total Hours: 45

Reference Books:

1. James, G., Witten, D., Hastie, T., Tibshirani, R., & Taylor, J. (2023). *An Introduction to Statistical Learning*. Springer Nature.
2. Strome, T. L. (2013). *Healthcare Analytics for Quality and Performance Improvement*. John Wiley & Sons.
3. Bloomfield, V. A. (2018). *Using R for Numerical Analysis in Science and Engineering*. CRC Press.
4. Stowell, S. (2015). *Instant R.*
5. Janert, P.K. (2018). *Data Analysis with Open Source Tools - a Hands-on Guide for Programmers and Data Scientists*.

Course Outcomes:

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

CO1: Utilize descriptive statistics and predictive modeling techniques to analyze healthcare data effectively.

CO2: Apply probability theory and Bayes Rule to model uncertainty and make predictions in healthcare data analysis.

CO3: Implement various regression algorithms, such as linear regression and logistic regression, to model relationships within healthcare datasets.

CO4: Employ classification algorithms, including K-nearest neighbors and support vector machines, to classify healthcare data accurately.

CO5: Utilize computational tools such as R packages for data analysis, time series analysis, and predictive modeling in healthcare contexts.

CO, PO MAPPING

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

Patient Safety, Standards and Ethics

PEI- Semester VII **Hours of Instruction/week: 3T**

Course Code: 24BEBE09 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the importance of patient safety against electrical hazards.
CLO2: To explain the patient safety laws, standards and regulations.

UNIT I Effects of Electricity 9

Physiological effects of electricity - important susceptibility parameters - microshock – macroshock hazards -patients' electrical environment - isolated power system - conductive surfaces.

UNIT II Patient Safety Laws and Regulations 9

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

UNIT III Standards and Testing 9

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system.

UNIT IV Patient Safety in Main Clinical Specialities 9

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

UNIT V Medical Ethics 9

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.

Total Hours: 45

Reference Books:

1. Webster, J. G. (2020). *Medical instrumentation: application and design*. Wiley.
2. Donaldson, L., Ricciardi, W., Sheridan, S., & Tartaglia, R. (2021). *Textbook of Patient Safety and Clinical Risk Management.* Springer.
3. Rozovsky, F. A., & Woods, J. R. (2016). *The Handbook of Patient Safety Compliance*. John Wiley & Sons.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Outline the importance of patient safety against electrical hazards.
CO2: Brief out the patient safety laws and regulations.
CO3: Explain the standards and testing of patient
CO4: Understand the concept of the patient safety specialties in clinical.
CO5: Know about various health care organization.

CO, PO MAPPING

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

Cell and Tissue Engineering

PEI- Semester VII **Hours of Instruction/week: 3T**

Course Code: 24BEBE10 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the physio-biological functions of cells and tissues, their interaction with biomaterials.

CLO2: To acquire knowledge about Stem cells and Tissue Engineering Application.

UNIT I Fundamentals of Cell Mechanism **9**

Structure and functions of cells, cell membrane, transport across membrane, cell potential, cell growth & cycle, cell adhesion and migration, cellular interaction- cell-cell and cell- matrix, cell transplantation.

UNIT II Basic Tissue Engineering **9**

Introduction to Tissue Engineering, structure and organization of tissue, development of tissue-Tissue exchange and diffusion of simple metabolites, Tissue Equivalent - Wound Healing Process - Biocompatibility and toxicity assessment.

UNIT III Biomaterials in Tissue Engineering **9**

Definition, Biological vs Non-biological materials, Extra Cellular Matrix, Collagen, Chitin & Degradable and Non-degradable materials, Polymer, Ceramics and Metals, Cell interaction with different materials, Scaffolds - Control releaser agents in Tissue Engineering, Cell interaction with suspension and gels, Tissue response to implants.

UNIT IV Stem Cells in Tissue Engineering **9**

Introduction of Stem cells, Hemopoietic Stem cells, Embryonic Stem cells, Adult stem cells, Cancer Stem cells, Cord Blood cells, Induced Pluripotent Stem cells, Stem cell identification, Surface markers & FACS analysis, Differentiation, Dedifferentiation and Immortalization - Application of stem cells in tissue Engineering.

UNIT V Tissue Engineering Application **9**

Synthetic components, Artificial organs, Joints and dental prostheses, Connective Tissue Engineering, Cardiovascular Tissue Engineering, Neural Tissue Engineering, Cell and Drug Delivery systems.

Total Hours: 45

Reference Books:

1. Lanza, R. P., Langer, R. S., & Vacanti, J. (2014). *Principles of tissue engineering*. Elsevier/Academic Press.
2. Starr, C., & Taggart, R. (2004). *Cell biology and genetics*. Thomson/Brooks/Cole.
3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular Biology of the Cell (*6th ed.). Garland Science.
4. Yoshito Ikada. (2011). *Tissue Engineering. Elsevier*.

Course Outcomes:

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

CO1: Recall the basic concepts of cell mechanism and importance of stem cells in tissue engineering.

CO2: Discuss the physio-biological functions of cells and tissue in wound healing mechanism.

CO3: Compare the properties of degradable and non-degradable biomaterials.

CO4: Describe the importance of bioengineered scaffolds and in tissue engineering applications.

CO5: Discuss the various applications in tissue engineering.

CO, PO MAPPING

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

Modeling of Physiological Systems

PE1 - Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBE11 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To explain the application of physiological models and vital organs.
CLO2: To describe the modeling techniques of physiological systems.

UNIT - I Basics of Physiological Systems **9**

Systems Analysis, examples of physiological control systems, differences between engineering and physiological control systems. Generalized system properties, mathematical approach, electrical analogs, linear models, Lung mechanics, Muscle mechanics, distributed parameter versus lumped parameter models, static analysis, regulation of cardiac output, blood glucose regulation, chemical regulation of ventilation, electrical model of neural control mechanism.

UNIT - II Circulatory System **9**

Physical, chemical and rheological properties of blood, problems associated with extracorporeal blood flow, dynamics of circulatory system.

UNIT - III Thermal Regulatory System **9**

Parameters involved, Control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystem of human body like skin core, etc and systems like within body, body- environment, etc.

UNIT - IV Ultra Filtration System **9**

Transport through cells and tubules, diffusion, facilitated diffusion and active transport, methods of waste removal, counter current model of urine formation in nephron, Modeling Henle's loop.

UNIT - V Respiratory System **9**

Modelling oxygen uptake by RBC and pulmonary capillaries, Mass balancing by lungs, Gas transport mechanisms of lungs, oxygen and carbon dioxide transport in blood and tissues.

Total Hours: **45**

References:

1. Cooney, D. O. (2017). *Biomedical Engineering Principles*. CRC Press.
2. Khoo, M. C. K., & Medicine, I. (2018). *Physiological control systems : analysis, simulation, and estimation*. Ieee Press ; Hoboken, New Jersey.
3. Bronzino, J. D., Enderle, J. D., & Blanchard, S. M. (2005). *Introduction to biomedical engineering*. Elsevier Academic Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Recall the basics and parametric aspects of physiological systems.
CO2: Describe the basics concepts and dynamics of circulatory system.
CO3: Analyze models of heat transfer.
CO4: Apply modeling techniques in renal that influences waste removal.
CO5: Apply modeling techniques for respiratory systems.

CO - PO MAPPING

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

Wearable Systems

PE1 - Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBE12 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To learn about sensors and signal processing.
CLO2: To acquire knowledge on wearable devices and its application.

UNIT - I Sensors **9**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS, Based Biosensors, E-Textiles, Bio compatibility.

UNIT - II Signal Processing **9**

Wearability issues-physical shape and placement of sensor, Technical challenges-sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining.

UNIT - III Energy Harvesting For Wearable Devices **9**

Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT - IV Wireless Health Systems **9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture, Introduction, Wireless communication techniques.

UNIT - V Applications of Wearable Systems **9**

Medical Diagnostics, Medical Monitoring- Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

Total Hours: **45**

References:

1. Bonfiglio, A., & Danilo De Rossi. (2014). *Wearable Monitoring Systems*. Springer Science & Business Media.
2. Sandeep K S Gupta, Tridib Mukherjee, & Krishna Kumar Venkatasubramanian. (2013). *Body area networks: safety, security, and sustainability*. Cambridge University Press.
3. Zhang, Y.-T. (2016). *Wearable Medical Sensors and Systems*. Springer.
4. Mehmet Rasit Yuce, & Khan, J. Y. (2012). *Wireless body area networks: technology, implementation, and applications*. Pan Stanford Pub.
5. Yang, G.-Z. (2014). *Body Sensor Networks*. London Springer.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Discuss the basic principle and technology underlying in the telemedicine.
CO2: Explain protocols behind encryption techniques for secure transmission of data.
CO3: Apply energy harvesting techniques for wearable devices.
CO4: Predict the wearability issues related to Body Sensor Networks.
CO5: Illustrate the applications of wearable systems.

CO - PO MAPPING

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

Telemedicine

PE2 - Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBE29 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To Learn the key principles for telemedicine and health and understand telemedical technology.
CLO2: To know telemedical standards, mobile telemedicine and it applications.

UNIT - I Fundamentals of Telemedicine 9
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

UNIT - II Type of Information & Communication Infrastructure for Telemedicine 9
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

UNIT - III Ethical and Legal aspects of Telemedicine 9
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.

UNIT - IV Picture Archiving and Communication System 9
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

UNIT - V Applications of Telemedicine 9
Teleradiology, Telepathology, Telecardiology, Teleoncology, Teledermatology, Telesurgery, e-Health and Cyber Medicine.

Total Hours: **45**

References:

1. Khandpur, R. S. (2017). *Telemedicine: Technology and Applications (mHealth, TeleHealth and eHealth).* Phi Learning.
2. Norris, A. C. (2002). *Essentials of Telemedicine and Telecare*. John Wiley & Sons.
3. Becker, M. (2016). *PACS And Imaging Informatics Basic Principles And Applications*.

Course Outcomes:
At the end of the course, students will be able to:

CO1: Discuss the basic principle and technology underlying in the telemedicine.
CO2: Understand the multimedia technologies in telemedicine.
CO3: Explain protocols behind encryption techniques for secure transmission of data.
CO4: Describe the various communication Systems used in telemedicine.
CO5: Apply telehealth technologies in various fields of healthcare with its ethical and legal aspects.

CO - PO MAPPING

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

Bio-Inspired Optimization Techniques

PE2 - Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBE30 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To Learn the collective systems such as ACO, PSO, and BCO
CLO2: To understand the most appropriate types of algorithms for different data analysis problems and to introduce some of the most appropriate implementation strategies.

UNIT - I Introduction **9**

Optimization Techniques: Introduction to Optimization Problems – Single and Muti- objective Optimization – Classical Techniques – Overview of various Optimization methods – Evolutionary Computing: Genetic Algorithm and Genetic Programming: Basic concept – encoding – representation – fitness function – Reproduction – differences between GA and Traditional optimization methods – Applications – Bio- inspired Computing (BIC): Motivation – Overview of BIC – usage of BIC – merits and demerits of BIC.

UNIT - II Swarm Intelligence **9**

Introduction – Biological foundations of Swarm Intelligence – Swarm Intelligence in Optimization – Ant Colonies: Ant Foraging Behavior – Towards Artificial Ants – Ant Colony Optimization (ACO) – SACO – Ant Colony Optimization Metaheuristic: Combinatorial Optimization – ACO Metaheuristic – Problem solving using ACO – Other Metaheuristics – Simulated annealing – Tabu Search – Local search methods – Scope of ACO algorithms.

UNIT - III Natural to Artificial Systems **9**

Biological Nervous Systems – artificial neural networks – architecture – Learning Paradigms – unsupervised learning – supervised learning – reinforcement learning – evolution of neural networks – hybrid neural systems – Biological Inspirations in problem solving – Behavior of Social Insects: Foraging –Division of Labor – Task Allocation – Cemetery Organization and Brood Sorting – Nest Building – Cooperative transport.

UNIT - IV Swarm Robotics **9**

Foraging for food – Clustering of objects – Collective Prey retrieval – Scope of Swarm Robotics – Social Adaptation of Knowledge: Particle Swarm – Particle Swarm Optimization (PSO) – Particle Swarms for Dynamic Optimization Problems – Artificial Bee Colony (ABC) Optimization biologically inspired algorithms in engineering.

UNIT - V Case Studies **9**

Other Swarm Intelligence algorithms: Fish Swarm – Bacteria foraging – Intelligent Water Drop Algorithms – Applications of biologically inspired algorithms in engineering. Case Studies: ACO and PSO for NP-hard problems – Routing problems – Assignment problems – Scheduling problems – Subset problems – Machine Learning Problems – Travelling Salesman problem.

Total Hours: **45**

References:

1. Bonabeau, E., Dorigo, M., & Theraulaz, G. (2010). *Swarm intelligence : from natural to artificial systems*. Oxford University Press.
2. Blum, C., & Merkle, D. (2008). *Swarm Intelligence Introduction and Applications.* Springer Berlin Heidelberg : Imprint: Springer.
3. Nunes, L., & Von, F. J. (2005). *Recent developments in biologically inspired computing*. Idea Group Pub.
4. Zomaya, A. Y. (2006). *Handbook of nature-inspired and innovative computing: integrating classical models with emerging technologies*. Springer Science Business Media.
5. Eberhart, R. C., Yuhui Shi, & Kennedy, J. F. (2001). *Swarm intelligence C.*

Course Outcomes:

At the end of the course, students will be able to:

CO1: Familiarize with the basics of optimization techniques.

CO2: Familiarity with the basics of several biologically inspired computing paradigms.

CO3: Select an appropriate bio-inspired computing method and implement for any application.

CO4: Describe the scope of swarm robotics.

CO5: Implement the Bio-inspired technique with other traditional algorithms.

CO - PO MAPPING

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

Robotics and Automation in Medicine

PE2- Semester: VII **Hours of Instruction/week: 3T**
Course Code: 24BEBE31 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the basic mechanism of robotic subsystems.
CLO2: To gain knowledge on design, analysis and working principle of robotics in medical field.

UNIT - I Introduction of Robotics **9**

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine.

UNIT - II Actuators and Grippers **9**

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models.

UNIT - III Manipulators & Basic Kinematics **9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems.

UNIT - IV Power Sources and Sensors **9**

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging, Laser- Acoustic, Magnetic fiber optic and Tactile sensor.

UNIT - V Robotics in Medicine **9**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

Total Hours: **45**

References:

1. Niku, S. B. (2020). *Introduction to Robotics: Analysis, Control, Applications*. Wiley.
2. Nagrath, M. (2018.). *Robotics and Control*. Tata McGraw-Hill Education.
3. Jazar, R. N. (2022). *Theory of applied robotics: kinematics, dynamics, and control.* Springer.
4. Spong, M. W., & M Vidyasagar. (2004). *Robot dynamics and control*. Wiley.
5. Rosen, J., Hannaford, B., Satava, R. M., & Springerlink (Online Service. (2011). *Surgical Robotics: Systems Applications and Visions.* Springer Us.
6. Constantinos Mavroidis, & Ferreira, A. (2013). *Nanorobotics*. Springer Science & Business Media.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Analyze the history and concepts of robotics.

CO2: Demonstrate proficiency in controlling pneumatic, hydraulic, and stepper motor actuators

CO3: Solve forward and inverse kinematic problems using electronic and pneumatic manipulator models.

CO4: Evaluate the functionality and performance of sensors and controllers.

CO5: Assess the application of robotics in various medical fields, including surgery and diagnostics.

CO - PO MAPPING

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

Computer Vision

PE2 - Semester: VII **Hours of Instruction/week: 3T**

Course Code: 24BEBE32 **No. of credits: 3**

Course Learning Objectives (CLOs):

CLO1: To understand the concepts of three-dimensional image formation and motion analyses of medical images.

CLO2: To apply the computer vision concepts for medical images.

UNIT - I Image Formation & Processing 9

Introduction - Photometric image formation - Point operators - Linear filtering - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization – Application.

UNIT - II Segmentation And Feature Alignment 9

Feature detection: Points and patches - Edges – Lines. Segmentation - Active contours: Snakes, Scissors - Split and merge: Region splitting and Merging - Mean shift and mode finding. Feature-based alignment: 2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration

UNIT - III Structure And Motion 9

Two-frame structure from motion - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

UNIT - IV 3D Reconstruction 9

Active range finding - Surface representations - Point-based representations - Volumetric representations - Model-based reconstruction. View interpolation - Layered depth images. Recognition: Object detection - Face recognition - Instance recognition - Category recognition

UNIT - V Applications 9

Medical image Segmentation - Gesture Recognition, Motion Estimation and Object Tracking. Case study: Computer Vision for Predictive Analytics.

Total Hours: **45**

References:

1. Davies, E. R. (2012). *Computer and Machine Vision*. Academic Press.
2. Forsyth, D. A., & Ponce, J. (2015). *Computer Vision: A Modern Approach*. Pearson Higher Ed.
3. Szeliski, R. (2022). *Computer vision: algorithms and applications*. Springer.
4. Jeremy, S. (2014). *Computer vision: models, learning, and inference (p. 83)*. Cambridge University Press.
5. Davies, E. R. (2018). *Computer vision: principles, algorithms, applications, learning*. Academic Press.

Course Outcomes:

At the end of the course, students will be able to:

CO1 Demonstrate basics of image acquisition and processing.
CO2 Analyze the various segmentation processes.
CO3 Interpret the motion of image frames.
CO4 Analyze 3D image reconstruction and recognition.
CO5 Identify the applications of related techniques.

CO - PO MAPPING

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	-	-	-	-	-	2	1	-	-
CO 2	2	2	3	-	-	-	-	-	2	1	1	-
CO 3	2	2	3	-	-	-	-	-	2	1	1	-
CO 4	2	2	3	2	-	-	-	-	2	1	1	-
CO 5	2	2	3	2	-	-	-	-	2	1	-	-