



THE KAVERY ENGINEERING COLLEGE

Mecheri, Mettur Tk. Salem Dt – 636 453.

(An Autonomous Institution Approved by AICTE, New Delhi & Affiliated to Anna University)

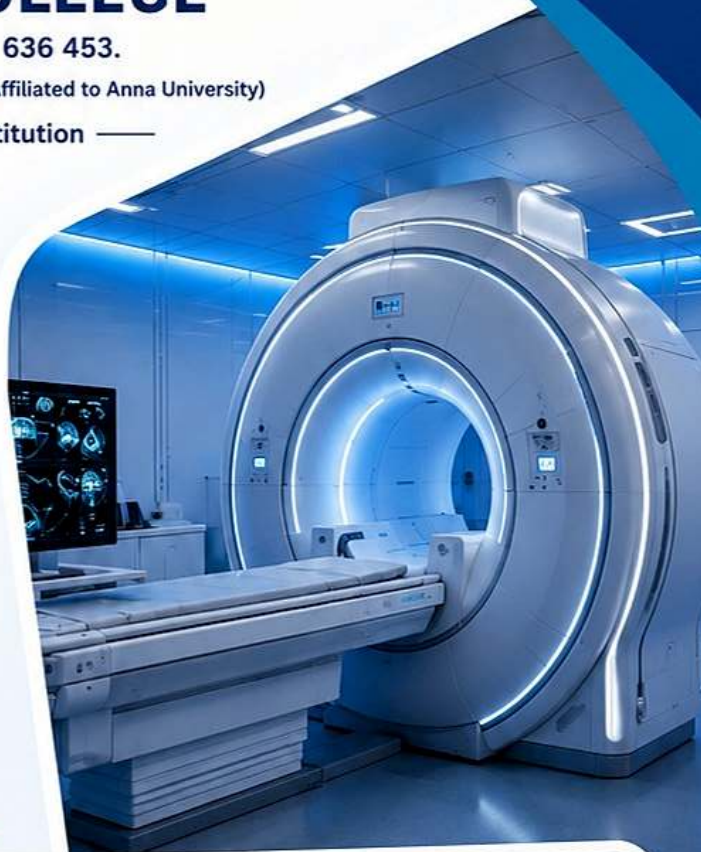
— An ISO 9001:2015 Certified Institution —

M.E. BIOMEDICAL ENGINEERING

AUTONOMOUS CURRICULUM

PG REGULATION 2024

SYLLABUS (SEMESTER I – IV)



**MEDICAL
IMAGING**



**BIOMATERIALS
& TISSUE
ENGINEERING**



**BIOMEDICAL
INSTRUMENTATION**



**REHABILITATION
ENGINEERING**



**AI & DATA
ANALYTICS IN
HEALTHCARE**



**AUTONOMOUS
CURRICULUM**
Industry Aligned
Future Ready



**INNOVATIVE
TEACHING**
Outcome Based
Learning



**RESEARCH &
INNOVATION**
Driving Solutions
for Healthcare



**INDUSTRY
COLLABORATION**
Stronger Connections
Better Opportunities



**EXCELLENCE
IN HEALTHCARE
TECHNOLOGY**

"Engineering Solutions for Better Healthcare"



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Accredited by NAAC with A+ grade & Recognised by UGC under section 2f & 12B
Mecheri, Salem Dt-636453, Tamilnadu



REGULATIONS 2024

M.E. BIOMEDICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR SEMESTER I TO IV

(Applicable to the students admitted from the Academic year 2025-2026 onwards)

VISION

- To be recognized as a leader in offering Biomedical Engineering education, research and application of knowledge to the society.

MISSION

- To equip the students with adequate knowledge in the field Biomedical Engineering with exemplary values.
- To encourage entrepreneurship and mould the students to learn new technologies in healthcare industry.
- To foster research and development in Biomedical Engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To enhance the skills of graduates to design a variety of electronic or computer based devices and develop software for applications including biomedical instrumentation, medical imaging, physiological measurement and biomedical signal processing.
- To enable the graduates to acquire technical knowledge and skills required for Biomedical Engineering that meets industrial and hospital requirements.
- To enable graduates to effectively involve themselves in product development for solving Biomedical Engineering cutting-edge technology problems.
- To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.
- To enable the graduates to recognize the need for lifelong learning, enhance their technical competencies throughout their career and become successful Entrepreneurs.


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PROGRAMME OUTCOMES (POs):

PO	Programme Outcomes
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/ document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO	Programme Specific Outcomes
PSO1	Ability to design and implement innovative solutions to solve complex problems in Biomedical Engineering.
PSO2	Competence to independently undertake research projects involving simulation, measurement, and product development in Biomedical Engineering -related fields.


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M. E Biomedical Engineering Syllabus 2024 R

(Applicable for the students admitted from the academic year of 2026-27)

SEMESTER - I										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BP101	Advanced Diagnostic and Therapeutic Equipment	3	0	0	3	3	40	60	100	PCC
24BP102	Biomedical Sensors and Instrumentation	3	0	0	3	3	40	60	100	PCC
24BP103	Human Anatomy and Physiology	3	0	0	3	3	40	60	100	PCC
24BP104	Medical Imaging Systems	3	0	0	3	3	40	60	100	PCC
PRMT2411	Research Methodology and IPR	2	0	0	2	2	40	60	100	RMC
Theory with Practical Course(s)										
24BP105	Bio Signal Processing	3	0	2	5	4	50	50	100	PCC
Practical / Employability Enhancement										
24BP106	Clinical Instrumentation and Design Laboratory	0	0	4	4	2	60	40	100	PCC
24T1482	Technical Seminar I	0	0	2	2	1	60	40	100	EEC
	Audit Course – I*	2	0	0	2	0	0	0	0	AC
Audit Course – I* is optional										
Total Credits to be earned					27	21				


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SEMESTER - II										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BP201	Medical Device Design	3	0	0	3	3	40	60	100	PCC
24BP202	Biomaterials and Biomechanics	3	0	0	3	3	40	60	100	PCC
24BP203	Soft Computing	3	0	0	3	3	40	60	100	PCC
	Professional Elective I	3	0	0	3	3	40	60	100	PEC
	Professional Elective II	2	0	0	3	3	40	60	100	PEC
Theory with Practical Course(s)										
24BP204	Applied Medical Image Processing	3	0	2	5	4	50	50	100	PCC
Practical / Employability Enhancement										
24BP205	Medical Device Design and Modelling Laboratory	0	0	4	2	2	60	40	100	PCC
24T2482	Technical Seminar II	0	0	2	2	1	60	40	100	EEC
	Audit Course – II*	2	0	0	2	0	0	0	0	AC
Audit Course – II* is optional										
Total Credits to be earned					26	22				


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SEMESTER - III										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
	Professional Elective III	3	0	0	3	3	40	60	100	PEC
	Professional Elective IV	3	0	0	3	3	40	60	100	PEC
	Professional Elective V	3	0	0	3	3	40	60	100	PEC
	Open Elective	3	0	0	3	3	40	60	100	OEC
Practical / Employability Enhancement										
24BPH01	Hospital Training/Biomedical Industry Training	0	0	0	0	2	60	40	100	EEC
24BPP01	Project Work I	0	0	12	12	6	60	40	100	EEC
Total Credits to be earned					24	20				

SEMESTER - IV										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Practical / Employability Enhancement										
24BPP02	Project Work II	0	0	24	24	12	60	40	100	EEC
Total Credits to be earned					24	12				


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AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SEMESTER - IV										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
PAXC2401	English for Research Paper Writing	2	0	0	0	0	60	40	100	AC
PAXC2402	Disaster Management	2	0	0	0	0	60	40	100	AC
PAXC2403	Constitution of India	2	0	0	0	0	60	40	100	AC
PAXC2404	நற்றமிழ் இலக்கியம்	2	0	0	0	0	60	40	100	AC
Total Credits to be earned					0	0				

RESEARCH METHODOLOGY COURSES (RMC)

SEMESTER - I										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
PRMT2411	Research Methodology and IPR	2	0	0	2	2	40	60	100	RMC
Total Credits to be earned					2	2				


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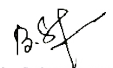
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LIST OF PROFESSIONAL ELECTIVE COURSES (PEC)

Semester II Elective I										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BPE01	Rehabilitation Engineering	3	0	0	3	3	40	60	100	PEC
24BPE02	Medical Optics	3	0	0	3	3	40	60	100	PEC
24BPE03	Human Assist Devices	3	0	0	3	3	40	60	100	PEC
24BPE04	Micro and Nano Fluids	3	0	0	3	3	40	60	100	PEC
24BPE05	Medical Device Standards and Regulation	3	0	0	3	3	40	60	100	PEC

Semester II Elective II										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BPE06	Tele Health Technology	3	0	0	3	3	40	60	100	PEC
24BPE07	Medical Robotics	3	0	0	3	3	40	60	100	PEC
24BPE08	Wearable Technologies	3	0	0	3	3	40	60	100	PEC
24BPE09	Brain Computer Interface	3	0	0	3	3	40	60	100	PEC
24BPE10	Wavelet Transforms and its Applications	3	0	0	3	3	40	60	100	PEC


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Semester III Elective III

Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BPE11	Hospital Planning, Organization and Management	3	0	0	3	3	40	60	100	PEC
24BPE12	Human Resource Management in Hospitals	3	0	0	3	3	40	60	100	PEC
24BPE13	Health Policy and Equipment Management	3	0	0	3	3	40	60	100	PEC
24BPE14	Hospital Waste management	3	0	0	3	3	40	60	100	PEC
24BPE15	Quality Assurance and Patient Safety standards in Hospitals	3	0	0	3	3	40	60	100	PEC

Semester III Elective IV

Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BPE16	Genetic Algorithms and Fuzzy Logics	3	0	0	3	3	40	60	100	PEC
24BPE17	Tissue Engineering	3	0	0	3	3	40	60	100	PEC
24BPE18	Embedded System and Internet of Things for Biomedical Applications	3	0	0	3	3	40	60	100	PEC
24BPE19	Medical Informatics	3	0	0	3	3	40	60	100	PEC


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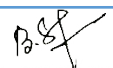
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Semester III Elective IV										
Course Code	Course Title	Hours / Week			TCP	Credit	Maximum Marks			Category
		L	T	P			CA	ESE	Total	
Theory Courses (s)										
24BPE20	Pattern Recognition Techniques and Applications	3	0	0	3	3	40	60	100	PEC
24BPE21	Data Analytics for Health Care Technologies	3	0	0	3	3	40	60	100	PEC
24BPE22	Mixed Reality	3	0	0	3	3	40	60	100	PEC
24BPE23	Medical Ethics and Standards	3	0	0	3	3	40	60	100	PEC

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	Category
			L	T	P		
1.	PEVO2414	Renewable Energy Technology	3	0	0	3	OEC
2.	POE2401	IPR, Biosafety and Entrepreneurship	3	0	0	3	OEC
3.	POE2403	Environmental Sustainability	3	0	0	3	OEC
4.	POE2405	Machine Learning and Deep Learning	3	0	0	3	OEC
5.	POE2406	IoT for Smart Systems	3	0	0	3	OEC
6.	POE2409	Principles of Multimedia	3	0	0	3	OEC
7.	POE2413	Sustainable Management	3	0	0	3	OEC
8.	POE2414	Micro and Small Business Management	3	0	0	3	OEC
9.	POE2415	Intellectual Property Rights	3	0	0	3	OEC
10.	POE2416	Ethical Management	3	0	0	3	OEC
11.	POE2420	Blockchain Technologies	3	0	0	3	OEC
12.	POE2423	Energy Conservation and Management in Domestic Sectors	3	0	0	3	OEC
13.	POE2424	Additive Manufacturing	3	0	0	3	OEC
14.	POE2425	Electric Vehicle Technologies	3	0	0	3	OEC


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SUMMARY

Sl. No.	NAME OF THE PROGRAMME :M.E.BIOMEDICAL ENGINEERING						PERCENTAGE
	SUBJECT AREA	CREDIT AS PER SEMESTER				TOTAL CREDITS	
		I	II	III	IV		
1.	PCC	18	15			33	44.4
2.	PEC		6	9		15	20.0
3.	RMC	2				2	2.66
4.	OEC			3		3	4.00
5.	EEC	1	1	8	12	22	29.30
6.	AC	0	0			0	0.00
	TOTALCREDIT	21	22	20	12	75	100

PCC - Professional Core Courses,
PEC - Professional Elective Courses
RMC - Research Methodology and IPR Courses,
OEC - Open Elective Courses,
EEC - Employment Enhancement Course


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Semester I

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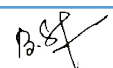


Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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Semester- I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP101	Advanced Diagnostic and Therapeutic Equipments	L	T	P	C	100
		3	0	0	3	
Course Objectives	To study biomedical measurements, assist devices, and hospital electrical safety.					

Unit-I	Cardiac Care Units:	(9)
Pacemakers, DC defibrillators (asynchronous & synchronous), patient monitoring systems, principles of bio-telemetry, echocardiography.		
Unit-II	Neurological Equipment:	(9)
Multi-channel EEG recording, clinical EEG (sleep patterns, epilepsy), evoked potentials (visual, auditory, somatosensory), EEG biofeedback, psycho physiological measurements, MEG principles.		
Unit-III	Muscular Equipment:	(9)
EMG (recording, waveform analysis, fatigue characteristics), muscle and nerve stimulators, nerve conduction velocity, EMG biofeedback, EGG (Electro-gastrograph), MMG (Magneto-myograph).		
Unit-IV	Respiratory Measurement and Assist Systems:	(9)
Lung Volume and vital capacity, Spirometer, measurements of residual volume. pneumotachometer – Airway resistance measurement, Whole body plethysmography. Intra- Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.		
Unit-V	Diathermy, Stimulator and Patient Safety:	(9)
Diathermy-Physiological effects of high frequency radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Hazards and safety procedures.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Geddes, L. A., & Baker, L. E. (2008). Principles of applied biomedical instrumentation (3rd ed.). John Wiley & Sons.
2	Webster, J. G. (2009). Medical instrumentation: Application and design (4th ed.). John Wiley & Sons.
3	Khandpur, R. S. (2014). Handbook of biomedical instrumentation (3rd ed.). Tata McGraw-Hill.
4	Carr, J. J., & Brown, J. M. (2014). Introduction to biomedical equipment technology. Pearson Education.
5	Cobbold, R. S. C. (1992). Transducers for biomedical measurements: Principles and applications. John Wiley & Sons.

COURSE OUTCOMES:

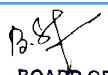
On completion of the course, the students will be able to

CO1:	Explain the principles, working, and clinical significance of biomedical equipment.
CO2:	Apply appropriate methods to measure bio potentials, physiological parameters, and therapeutic responses
CO3:	Analyze biomedical signals and equipment performance for diagnosis, safety, and effective patient monitoring.
CO4:	Design and evaluate biomedical instruments with safety protocols
CO5:	Design stimulators and test the electrical safety of medical equipment in the hospital environment.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	3	3	2
CO2	3	-	3	3	2
CO3	3	-	3	3	2
CO4	3	-	3	3	2
CO5	3	-	3	3	2
Avg.	3	-	3	3	2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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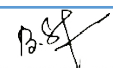


Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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Semester- I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP102	Biomedical Sensors and Instrumentation	L	T	P	C	100
		3	0	0	3	
Course Objectives	To study measurement principles, errors, and biosensors in medicine, and to understand biopotentials and bioamplifiers					

Unit-I	Biomedical Sensors & Transducers:	(9)
Resistive transducers (strain gauge – gauge factor, configuration, displacement & pressure sensing, biomedical applications), RTDs, thermistors, temperature sensors, capacitive and inductive transducers, LVDT, thermocouples.		
Unit-II	Biopotential and Its Measurements:	(9)
Origin and propagation of biopotentials, electrode- electrolyte and electrode-skin interface, half-cell potential, polarization, surface/needle/micro electrodes & equivalent circuits, non-polarizable electrodes.		
Unit-III	Measurement of Non-Electrical Parameter:	(9)
Measurements of Respiration Rate, Temperature, Pulse rate, Blood pressure Measurements- Direct, Indirect. Blood flow Measurements – In vitro, In vivo, Gas flow measurements. Blood cell counter.		
Unit-IV	Biosignals & Measurement Systems:	(9)
Characteristics of biosignals (frequency, amplitude), ECG (Einthoven's triangle, 12-lead system), EEG (10-20 system, recording modes), EMG (recording modes), PCG, ERG, EOG, EGG – recording methods, waveform analysis, abnormal signals, evoked responses.		
Unit-V	Bioamplifiers & Signal Conditioning:	(9)
Need for bioamplifiers, single-ended & differential bioamplifiers, impedance matching, isolation amplifiers (transformer & optical isolation), isolated DC & AC carrier amplifiers, power-line interference removal, right-leg driven ECG amplifier, band-pass filtering, recording systems.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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3	Cromwell, L. (2015). Biomedical instrumentation and measurement. Prentice Hall of India.
4	Geddes, L. A., & Baker, L. E. (1989). Principles of applied biomedical instrumentation. John Wiley & Sons.
5	Khandpur, R. S. (2014). Handbook of biomedical instrumentation. McGraw Hill Education India.
6	Webster, J. G. (2009). Medical instrumentation: Application and design. John Wiley & Sons.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the working principles of biomedical sensors, electrodes, bio potentials, and signal acquisition systems.
CO2:	Apply appropriate methods to measure bio potentials, physiological parameters, and therapeutic responses
CO3:	Analyze biomedical signals and equipment performance for diagnosis, safety, and effective patient monitoring.
CO4:	Design and evaluate biomedical instruments with safety protocols
CO5:	Describe the performance of the classification of biosignals

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP103	Human Anatomy and Physiology	L	T	P	C	100
		3	0	0	3	
Course Objectives	To study animal cell organelles, human body systems, sensory and accessory organs, and understand the anatomy, physiology, and regulatory mechanisms of the human body.					

Unit-I	Organization of the Human Body:	(9)
Levels of organization, anatomical planes, cell structure & functions, plasma membrane, cell transport, cell signaling, cell cycle regulation, action potential, homeostasis, specialized tissues.		
Unit-II	Integumentary, Skeletal, Muscular and Respiratory Systems:	(9)
Skin (structure & functions), bones (types, formation, joints, cartilage), muscular system (parts, movement), respiratory system (structure, types, breathing, regulation).		
Unit-III	Cardiovascular, Lymphatic and Endocrine Systems:	(9)
Heart structure & conduction system, cardiac cycle, cardiac muscle properties, heart rate regulation, blood vessels, blood composition, blood groups. Lymphatic organs, functions. Endocrine glands (pituitary, thyroid).		
Unit-IV	Nervous, Sense Organs and Reproductive Systems:	(9)
Neuron structure, properties, nerve impulse, CNS & PNS, brain parts, reflex mechanism. Sensory systems (eye, ear). Reproductive system (male & female anatomy).		
Unit-V	Digestive and Urinary Systems :	(9)
Digestive organs, digestion & absorption, kidney & nephron structure, urine formation, urinary reflex, blood pressure regulation by urinary system.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Ganong, W. F. (2010). Review of medical physiology. McGraw Hill.
2	Guyton, A. C., & Hall, J. E. (2015). Medical physiology. Elsevier Saunders.
3	Martini, F. H., Nath, J. L., & Bartholomew, E. F. (2014). Fundamentals of anatomy and physiology). Pearson Publishers.
4	Marieb, E. N. (2015). Essentials of human anatomy and physiology. Pearson Education.
5	Pocock, G., & Richards, C. D. (2017). The human body: An introduction for biomedical and health sciences. Oxford University Press.
6	Solomon, E. P. (2015). Introduction to human anatomy and physiology. W.B. Saunders Company.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the structural organization of the human body from cells to organ systems.
CO2:	Apply anatomical and physiological knowledge to measure, record, and interpret basic body functions.
CO3:	Analyze the integration of various systems in maintaining homeostasis.
CO4:	Design activities to explore structure-function relationships of human organ systems
CO5:	Apply concept and knowledge of human systems to novel technical and/or clinical scenarios

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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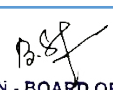


Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP104	Medical Imaging Systems	L	T	P	C	100
		3	0	0	3	
Course Objectives	To study the principles of Medical Imaging Systems					

Unit-I	X-ray Imaging Modalities:	(9)
Principle and production of soft X - Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography.		
Unit-II	CT and Computer Aided Tomography:	(9)
Principle, multisection radiography, computerized axial tomography, detectors, image reconstruction, spiral CT, transverse tomography, 3D imaging, convolution and back-projection, multislice CT, artifacts.		
Unit-III	MRI and Emission Computed Tomography:	(9)
Principle of MRI, MRI instrumentation, tissue characterization, MR spectroscopy, functional MRI, radiation detectors, gamma camera, PET, SPECT, PET/CT, PET/MRI.		
Unit-IV	Ultrasound Imaging:	(9)
Ultrasonic frequency for medical application, display modes (A, B, M), ultrasonic probes, real-time echo, 2D scanner.		
Unit-V	Quality Metrics in Medical Imaging:	(9)
Global parameter assessment, spatial and frequency assessment, image processing assessment, observer assessment, image discrimination models, figure of merit, AI in imaging systems.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging, Volume 1. Physics and Psychophysics, SPIE, 2000
2	Donald W. Mc Robbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI from Picture to proton, Cambridge University press, second edition, New York 2007.
3	Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1989
4	Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier, 2005.
5	Jerry L. Prince, Janathan M. Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014.
6	Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second edition, 2000.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the principles of X-ray and ultrasound imaging systems and their clinical applications.
CO2:	Apply reconstruction techniques in CT and MRI to generate sectional images.
CO3:	Analyze different medical imaging modalities (MRI, PET, SPECT) for tissue characterization and functional studies..
CO4:	Evaluate and design imaging quality metrics and AI based methods for Medical image assessment.
CO5:	Apply concept and knowledge of quality Metrics in Medical Imaging

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PRMT2411	Research Methodology and IPR	L	T	P	C	100
		2	0	0	2	
Course Objectives	• To understand the fundamentals of research methodology, research design, and various research processes. • To develop knowledge in qualitative and quantitative data collection methods, sampling techniques, and measurement tools. • To apply statistical and multivariate analysis techniques for data interpretation and hypothesis testing. • To enhance the ability to prepare technical reports and present research findings effectively through oral and written communication. • To understand the concepts, importance, and legal aspects of Intellectual Property Rights (IPR), patents, trademarks.					

Unit-I	RESEARCH DESIGN	(6)
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.		
Unit-II	DATA COLLECTION AND SOURCES	(6)
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.		
Unit-III	DATA ANALYSIS AND REPORTING	(6)
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.		
Unit-IV	INTELLECTUAL PROPERTY RIGHTS	(6)
Intellectual Property - The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.		
Unit-V	PATENTS	(6)
Patents - objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		

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Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Total No of Periods to be Taught

30

REFERENCES:

1	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to

CO1:	Explain the fundamentals of research design, research process, qualitative research methods, experiments.
CO2:	Apply appropriate data collection techniques, measurement scales.
CO3:	Analyze and interpret research data using statistical tools, hypothesis testing, measures of association, and multivariate analysis techniques.
CO4:	Prepare and present effective technical reports and oral presentations to communicate research findings and insights.
CO5:	Demonstrate understanding of Intellectual Property Rights, trade secrets, trademarks, biodiversity-related IPR.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	-	-
CO2	3	3	2	2	2
CO3	3	2	3	2	2
CO4	3	3	2	-	1
CO5	3	3	3	2	1
Avg.	3	2.8	2.6	1.2	1.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					

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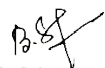


Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP105	Bio Signal Processing	L	T	P	C	100
		3	0	2	4	
Course Objectives	To study biosignal characteristics, apply filtering techniques, and demonstrate wavelet- based feature extraction in bio signal processing.					

Unit-I	Signal, System and Spectrum	(9)
Characteristics of biomedical signals, types of noise (random, structured, physiological), IIR and FIR filters, spectrum analysis (PSD, cross- spectral density, coherence function, cepstrum, homomorphic filtering), estimation of mean in finite time signals.		
Unit-II	Time Series Analysis and Spectral Estimation	(9)
Time series models, linear prediction, process order estimation, non-stationary processes, fixed/adaptive segmentation, applications in EEG, PCG, HRV, model-based ECG simulator. Spectral estimation (Blackman-Tukey, periodogram, model-based).		
Unit-III	Adaptive Filtering and Wavelet Detection	(9)
Adaptive filtering, LMS adaptive filter, adaptive noise cancellation in ECG, FECG, EEG; wavelet detection in ECG, structural features, matched filtering, adaptive wavelet detection, overlapping wavelets.		
Unit-IV	Analysis of Biosignal	(9)
Artifact removal, event detection in ECG, P wave, QRS complex, T wave detection, correlation analysis of ECG, averaging of PCG/ECG/EMG signals.		
Unit-V	Biosignal Classification	(9)
Statistical signal classification, linear discriminant function, feature selection, backpropagation neural network, biosignal classification using CNN & LSTM.		
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Babu, P. R. (2014). Digital signal processing. SciTech Publications.
2	Ifeachor, E. C., & Jervis, B. W. (2002). Digital signal processing: A practical approach Pearson Education.
3	Rao, R. M., & Bopardikar, A. S.(2000). Wavelet transforms: Introduction to theory and its applications. Pearson Education.
4	Rangaraj, M. R. M. (2015). Biomedical signal analysis: A case- study approach. Wiley IEEE Press.
5	Tompkins, W. J. (2006). Biomedical digital signal processing. Prentice Hall of India.

List of Exercises/Experiments

- 1.Design and implementation of FIR & IIR filters for ECG noise removal.
2. Power Spectral Density (PSD) estimation of EEG signals using Welch's method.
3. Time series modeling of ECG signals using linear prediction (AR model).
4. Spectral estimation using Periodogram & Blackman-Tukey methods on HRV signals.
- 5.Biosignal analysis in virtual instrumentation platform

Total No of Periods to be Taught

15

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the characteristics of biomedical signals, noise sources, and spectrum analysis methods.
CO2:	Apply time series and spectral estimation techniques to analyze biosignals.
CO3:	Analyze biosignals using adaptive filtering, wavelet- based detection, and artifact removal methods.
CO4:	Design and implement signal classification models
CO5:	Classify the different types of Biosignals


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LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S.NO	DESCRIPTION OF EQUIPMENT	REQUIRED NUMBERS
1	Simulation soft wares (signal processing toolbox and simu link)	Five user
2	Sensor Module-User Interface. (acquiring Biosignals like ECG, EEG, EMG)	Single Unit

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester I

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP106	Clinical Instrumentation and Design Laboratory	L	T	P	C	100
		0	0	4	2	
Course Objectives	To design the design of bio medical instrumentation Circuits. And the critical care equipment in medical field.					

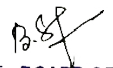
List of Exercises/Experiments

1. Recording and analysis of Electromyogram signals.	
2. Recording of EEG signal.	
3. Measurement of respiratory parameters using spirometer	
4. Plotting of human auditory response using audiometer.	
5. Performance and testing of surgical diathermy unit using diathermy Analyser.	
6. Measurement of Vital parameters using patient monitoring system and biotelemetry.	
7. Electrical safety testing of medical equipment.	
8. Study of different types of muscle stimulator waveforms.	
9. Study the working of Defibrillator and pacemakers	
10. Study of ventilators	
11. Develop prototype using 3D printing for Biomedical applications.	
Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%	
Total No of Periods to be Taught	45

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the role of preamplifiers and isolation circuits in biomedical applications.
CO2:	Apply amplifier design techniques for bio-signal acquisition..
CO3:	Analyze the operation of medical and critical care equipment.
CO4:	Design 3D printing models for biomedical applications.
CO5:	Explain the assessment method to quantify the presence of noise in the image.


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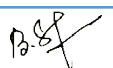


LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.NO	DESCRIPTION OF EQUIPMENT	REQUIRED NUMBERS
1	Defibrillator Unit	1No.
2	Pacemaker Simulator	1No.
3	Pulse Oximeter Design Components	2set.
4	HR Monitor Design Components	2Set
5	Respiratory rate measurement Design Components	2Set
6	Multi parameter (ECG, EMG, EEG) Simulator	2No.
7	Function generator, DSO, Regulated Power supplies, Bread boards	10 each
8	ICLM324, AD620, INA series (126, 128etc.), 555Timer	20 each
9	Opto Isolator IC:MCT2E	1No.
10	Software tool for PCB design	1No.
11	2-Dand 3-D Modelling software	1No.
12	3-D printer and Software	1No.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Semester II

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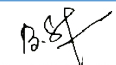


Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP201	Medical Device Design	L	T	P	C	100
		3	0	0	3	
Course Objectives	➤ To understand about basic design processes of medical device ➤ To introduce with basics of design, construction and development devices ➤ To follow a deterministic engineering design process to create new products. ➤ To apply engineering theory to practice. ➤ To perform design transfer and counter measure development.					

Unit-I	Introduction:	(9)
Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modelling, machine elements, ergonomics and prototyping.		
Unit-II	Product Design:	(9)
Definition, History and Modern Practice – Designs; Design and Product Life Cycle; Design Process; Medical device, Challenges in medical device, Understanding the innovation cycle, Good Design Practice. Understanding, analyzing and validating user needs, Screening Needs, Technical Requirements, Concept Generation – Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.		
Unit-III	Hardware and Software Design:	(9)
Hardware design, Hardware risk analysis, Design and project merits, Design for six sigma, software design, software coding, software risk analysis, software metrics, licensing and alternate pathways.		
Unit-IV	Design Transfer and IPR :	(9)
Transfer to manufacturing, documents and deliverables. Standard-ISO, IES, Intellectual Property - Patents, Copy rights, Trademarks, Trade secrets.		
Unit-V	Manufacturing and Business Strategies:	(9)
Lean Manufacturing – Toyota Production System, Good Manufacturing Practices, Framework for Product Strategy – Core Strategic Vision (CSV), Characteristics of good CSV, Opportunity Identification Process & Generating Opportunities, Quality of Opportunities – Intellectual property strategy – research and development strategy – clinical strategy – regulatory strategy – quality and process management – reimbursement strategy – marketing and stakeholder strategy – sales and distribution strategy – competitive advantage and business strategy.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		


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Total No of Periods to be Taught	45
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REFERENCES:	
1	Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner- Bonneau 'Handbook of Human Factors in Medical Device Design,' CRC press,2010
2	Peter J. Ogradnik, "Medical Device Design: Innovation from Concept to Market," Academic Press Inc; 1st Edition, 2012
3	Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems," Third Edition, 2014
4	Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, "Biodesign: The Process of Innovating Medical Technologies,"
5	Cambridge University Press; 1 edition, 2009.

COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Analyze and identify user needs, perform prior art searches, and generate innovative concepts for medical device design.
CO2:	Apply engineering principles to hardware and software design, risk analysis, and coding practices in medical devices.
CO3:	Implement design transfer, documentation, and intellectual property management including patents, trademarks, and regulatory compliance.
CO4:	Develop manufacturing, business, and development strategies for medical devices using lean manufacturing, product planning, market analysis, and strategic frameworks.
CO5:	To perform design transfer and countermeasure development.

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	-	3	2
CO2	3	3	3	3	3
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Avg.	3	3	2.2	3	3
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP202	Biomaterials and Biomachanics	L	T	P	C	100
		3	0	0	3	
Course Objectives	To introduce concepts of materials, surface and tissue placement in biomaterial functions and to understand diverse elements controlling biological responses to materials.					

Unit-I	Introduction to Biomaterials:	(9)
Definition of biomaterials, Metals, Ceramics, Polymers and Biomimetic Materials, Composites. mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound Kinetics, Bio Compatibility, Material preparation, Properties, uses in medicine and biosciences and failure mechanisms.		
Unit-II	Sterilization and Testing of Biomaterials:	(9)
Sterilization techniques. ETO, gamma radiation, autoclaving. Effects of sterilization on material properties. Testing with Tissue Culture – in vitro and in vivo assessment of biocompatibility, testing with Soft Tissues and testing at non Thrombogenic surface – blood compatibility and thrombogenicity, ISO 10993- standard for assessment of biocompatibility.		
Unit-III	Tissue and Fluid Biomechanics:	(9)
Mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models. Electrical properties of bone, type of fractures. Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Structure and functions - Material Properties, Modeling. Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, non-Newtonian fluid, viscoelastic fluids, Velocity and pressure profile of blood flow, Resistance against flow		
Unit-IV	Movement Biomechanics and Implants:	(9)
Gait analysis. Analysis of Joints forces in Elbow, knee and shoulder. General concepts of Implants, classification of implants, soft tissue and Hard tissue replacement, Design of orthopedic implant, specifications for a prosthetic joint, fixation of implants.		
Unit-V	Cardiac & Respiratory Mechanics:	(9)
Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. Function of native heart valves, artificial heart valves, biological and mechanical valves development, testing of valves. Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, Airway resistance, Physics of lung diseases.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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1	Jonathan Black, Biological Performance of Materials- Fundamentals of bio compatibility, 4th Edition, CRC Press 2005.
2	Larry L. Hench and Julian R. Jones, Biomaterials, Artificial organs, and Tissue Engineering, 2005.
3	Y. C. Fung, Biomechanics: Mechanical properties in living tissues, Springer Verlag, New York 1981.
4	Susan J. Hall, Basics Bio Mechanics 4 th Edition, McGraw-Hill Publishing Co, 2002.
5	Subrata pal, Text book of Biomechanics, Viva education private limited, 2009.
6	C. R Ethier and C. A. Simmons, Biomechanics from cells to organisms, Cambridge University Press, 2007.
7	D. Dawson and Right, Introduction to Bio-mechanics of joints and joint replacement, Mechanical
8	Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons,

COURSE OUTCOMES: On completion of the course, the students will be able to

CO1:	Explain the properties, surface chemistry, biocompatibility, and sterilization of biomaterials, including metals, ceramics, polymers, composites, and biomimetics.
CO2:	Apply biomechanics principles to analyze mechanical properties of bones, soft tissues, and fluids, including stress, strain, viscoelasticity, and blood flow dynamics.
CO3:	Evaluate the design and functional requirements of orthopedic and cardiovascular implants, including joint prostheses, artificial valves, and fixation strategies.
CO4:	Perform experimental and analytical studies, including stress-strain analysis, hemocompatibility testing, torque measurements, and limb inertia determination using biomechanical tools.
CO5:	Understand the Cardiac & Respiratory Mechanics

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Avg.	2.4	2.4	2.4	2.4	2.4
1 - Slight, 2 - Moderate, 3 -Substantial, BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP203	Soft Computing	L	T	P	C	100
		3	0	0	3	
Course Objectives	To introduce the concept of machine learning and learn and apply neural networks for pattern classification and regression problems. To introduce the ideas of fuzzy sets, fuzzy logic.					

Unit-I	Introduction to Machine Learning :	(9)
Machine Learning – Basic Concepts in Machine Learning – Types of Machine Learning – Examples of Machine Learning – Applications – Linear Models for Regression – Linear Basis Function Models – The Bias - Variance Decomposition – Bayesian Linear Regression – Dimensionality Reduction.		
Unit-II	Neural Networks:	(9)
Biological Neurons and their Artificial models, Learning Rules, Single Layer Perceptron Classifiers., Back Propagation Network, generalized delta rule, Associative Memory, Adaptive Resonance Theory (ART) Network Descriptions.		
Unit-III	Fuzzy Logic Systems:	(9)
Fuzzy Logic System: Basic of fuzzy logic theory, crisp and fuzzy sets, Basic set operation like union, intersection, complement, T-norm, T-conorm, fuzzy relations, fuzzy if-then rules, fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS), ANFIS architecture, Hybrid Learning Algorithm.		
Unit-IV	Evolutionary Computation & Genetic Algorithms:	(9)
Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA – GA Algorithm – Classification of GA – Applications.		
Unit-V	Advances and Applications:	(9)
Support Vector Machines, RBF Network. Introduction to Deep Learning– Convolutional Neural Network. Case Study– Neural Network based Classification of Biosignal and Medical Images.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Tom M. Mitchell, "Machine Learning," McGraw-Hill Education (INDIAN EDITION), 2013
2	Ethem Alpaydin, "Introduction to Machine Learning," 2nd Ed., PHI Learning Pvt. Ltd., 2013.
3	T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer; 1 st edition, 2001.
4	Wolfgang Ertel, "Introduction to Artificial Intelligence", Springer, 2nd Edition, 2017
5	Nello Cristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods," Cambridge University Press. 2013
6	Timothy Ross, "Fuzzy Logic with Engineering Applications," Wiley, 2016
7	David E. Goldberg, "Genetic Algorithms in search, Optimization & Machine
8	Neural Networks and Deep Learning by Michael Nielsen., March 2017.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the fundamentals of machine learning, including supervised and unsupervised learning, linear regression, dimensionality reduction, and Bayesian approaches.
CO2:	Apply artificial neural network techniques, including perceptrons, back propagation networks, associative memory, and ART networks for classification and regression problems.
CO3:	Understand and implement fuzzy logic systems, including fuzzy sets, rules, reasoning, and neuro-fuzzy models like ANFIS with hybrid learning algorithms.
CO4:	Implement evolutionary computation techniques, genetic algorithms, support vector machines, RBF networks, and introductory deep learning (CNNs) for practical applications in biomedical signal and image classification.
CO5:	To study about the advances and applications of deep Learning- Convolution Neural Network.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Avg.	2.4	2.4	2.4	2.4	2.4
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP204	Applied Medical Image Processing	L	T	P	C	100
		3	0	2	4	
Course Objectives	To understand the fundamentals of medical image processing techniques and understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images. To provide information about various medical imaging modalities and provide information about classification and image visualization in medical image processing projects					

Unit-I	Fundamentals of Image Processing:	(9)
Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization - Image transforms		
Unit-II	Medical Image Enhancement and Restoration:	(9)
Image Enhancement operation, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration-degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering.		
Unit-III	Medical Image Representation:	(9)
Pixels and voxels - algebraic image operations - gray scale and color representation - depth - color and look up tables - image file formats - DICOM- other formats - Analyse 7.5, NifTI and Interfile, Image quality and the signal to noise ratio.		
Unit-IV	Medical Image Analysis and Classification:	(9)
Image segmentation- pixel based, edge based, region-based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature, and image classification - Statistical, Rule based, Neural Network approaches.		
Unit-V	Image Registrations and Visualization	(9)
Image Registration: Rigid body transformation - Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, 2-D display methods, 3-D display methods, 3-D Echocardiography, virtual reality based interactive visualization.		
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Atam P. Dhawan, Medical Image Analysis, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
2	Anil K Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.
3	Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018.
4	Wolfgang Birkfellner, "Applied Medical Image Processing – A Basic course," CRC Press, 2011
5	Geoff Dougherty, Digital Image Processing for Medical Applications, 1st Edition, Cambridge University Press, 2010.
6	John L. Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications" Marcel Dekker Inc., New York, 2004
7	Kavyan Najarian and Robert Splerstor, "Biomedical signals and Image processing", CRC – Taylor and Francis, New York, 2006
8	Milan Sonka et al, "Image Processing, Analysis and Machine Vision," Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
9	Ravikanth Malladi, Geometric Methods in Bio-Medical Image Processing (Mathematics and Visualization), 1st Edition, Springer-Verlag Berlin Heidelberg 2002.

List of Exercises/Experiments

1. Preprocessing of medical images	
2. Filtering of medical images.	
3. Edge detection using Python	
4. Segmentation of ROI in medical images.	
5. Feature extraction in medical images	
6. Steganography using Open CV.	
7. Medical image fusion.	
8. Statistical analysis of features	
9. Neural network-based classification.	
Total No of Periods to be Taught	30


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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understand fundamentals of image processing, including image perception, sampling, quantization, transforms, and image fidelity metrics.
CO2:	Apply medical image enhancement and restoration techniques, including spatial and frequency domain filtering, noise reduction, and color image enhancement.
CO3:	Represent and analyze medical images using pixels/voxels, algebraic operations, grayscale/color models, DICOM and other formats, and evaluate image quality metrics (SNR, MTF).
CO4:	Perform medical image analysis, segmentation, feature extraction, classification (statistical, rule- based, neural networks), image registration, and visualization using 2D/3D and volume rendering techniques.
CO5:	Study the different types of image visualization

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Avg.	2.4	2.4	2.4	2.4	2.4

1 - Slight, 2 - Moderate, 3 -Substantial, BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BP205	Medical Device Design and Modelling Laboratory	L	T	P	C	100
		0	0	4	2	
Course Objectives	• To understand various voltage protection circuits • To understand data acquisition and displaying systems. • To gain knowledge about various noise cancellation systems. • To understand the interfacing mechanism of DSP.					

List of Exercises/Experiments

1. Modelling of lung mechanics
2. Modelling of cardiovascular system
3. Simulation and kinematic analysis of musculoskeletal model
4. LabVIEW based biosignal analysis
5. Design of implants/ Joints using FEM
6. Finite element analysis of blood vessels.
7. Stress strain analysis using FEM software.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Total No of Periods to be Taught	30
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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Apply modeling techniques to physiological systems such as lung mechanics and cardiovascular system.
CO2:	Perform simulation and kinematic analysis of musculoskeletal systems and biomedical implants using computational tools.
CO3:	Conduct biosignal acquisition, analysis, and noise cancellation using LabVIEW and DSP interfacing.
CO4:	Use Finite Element Method (FEM) to analyze stress, strain, and mechanical properties of implants, joints, and blood vessels.
CO5:	To understand the interfacing mechanism of DSP.


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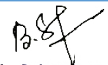


LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.NO	DESCRIPTION OF EQUIPMENT	REQUIRED NUMBERS
1	Any one of these circuit simulation software (Multisim, LT spice, Logisim- evolution, Ng spice, Altium software,)	3user
2	DSP processor kit	3numbers
3	Accelerometer sensor	5Nos
4	Data Acquisition System (DAQ)	1No

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	3	2
CO2	3	3	3	3	3
CO3	3	3	-	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Avg.	3	3	2.4	3	2.8
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester- III

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPH01	Hospital Training/ Biomedical Industry Training	L	T	P	C	100
		0	0	0	2	
Course Objectives	- Observe medical professionals at work in the wards and the roles of Allied Health Professionals; - Provide access to healthcare Professionals to get a better understanding of their work; - Demonstrate patient-care in a hospital setting.					

S. No	Department Visit
1	Cardiology
2	ENT
3	Ophthalmology
4	Orthopaedic and Physiotherapy
5	ICU/CCU
6	Operation Theatre
7	Neurology
8	Nephrology
9	Radiology
10	Nuclear Medicine
11	Pulmonology
12	Urology
13	Obstetrics and Gynaecology
14	Emergency Medicine
15	Biomedical Engineering Department
16	Histo Pathology
17	Biochemistry
18	Paediatric/Neonatal
19	Dental
20	Oncology
21	PAC's
22	Medical Records / Telemetry


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Students need to complete training in any leading Multi-speciality hospital/ Biomedical Industry for a period of 15 days. They need to prepare an extensive report and submit to their respective course in-charges during the session. Out of the following departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments during laboratory hours.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Advocate a patient-centred approach in healthcare Communicate with other health professionals in a respectful and responsible
CO2:	Manner Recognize the importance of inter-professional collaboration in healthcare
CO3:	Propose a patient-centred inter-professional health improvement plan based upon• the patient's perceived needs
CO4:	Use the knowledge of one's own role and those of other professions to address
CO5:	The healthcare needs of populations and patients served.

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Department	Biomedical Engineering	Programme Code & Name	482 - ME BME
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Semester III

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPP01	PROJECT WORK I	L	T	P	C	100
		0	0	12	6	
Course Objectives	</					

SYLLABUS

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a vivavoce examination by a panel of examiners including one external examiner.

Total No of Periods to be Taught

180 periods

COURSE OUTCOMES:

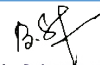
On completion of the course, the students will be able to

CO1:	Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2:	Summarize the importance of literature review.
CO3:	Identify the problem.
CO4:	Solve the identified problem based on the formulated methodology.
CO5:	Interpret and present the findings of the work conducted.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	3	3	3
Avg.	3	3	3	-	-	-	-	-	-	-	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482 - M.E BME
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Semester IV

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPP02	PROJECT WORK II	L	T	P	C	100
		0	0	24	12	
Course Objectives	➤ To solve the identified problem based on the formulated methodology ➤ To develop skills to analyze the research problem ➤ To develop skills to discuss the test results, and make conclusions					

SYLLABUS

The student should continue the phase I work on the selected topic as per the formulated methodology/ Undergo internship. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

Total No of Periods to be Taught	360 periods
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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2:	Summarize the importance of literature review.
CO3:	Identify the problem.
CO4:	Solve the identified problem based on the formulated methodology.
CO5:	Interpret and present the findings of the work conducted.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	3	3	3
Avg.	3	3	3	-	-	-	-	-	-	-	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy


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Programme Elective Courses

Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester II- Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE01	Rehabilitation Engineering	L	T	P	C	100
		3	0	0	3	
Course Objectives	To learn the basics of rehabilitation engineering and study about principle of rehabilitation engineering. Understand different types of Therapeutic Exercise Technique and tests to assess the hearing loss and development techniques of electronic devices for visually and auditory impaired. To study about various orthopedic devices and prosthetic devices					

Unit-I	Introduction to Rehabilitation :	(9)
Rehabilitation: Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer		
Unit-II	Principle of Rehabilitation:	(9)
Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.		
Unit-III	Therapeutic Exercise Technique:	(9)
Co-ordination exercises, Frenkels exercises, Gait Analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilization exercises, Endurance exercises.		
Unit-IV	Management of Communication & Virtual Reality:	(9)


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Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. 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	Orthotic, Prosthetic Devices & Restoration Techniques:
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(9)

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAF0. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and externally powered limb prosthetics. Functional Electrical Stimulation Systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

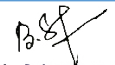
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Total No of Periods to be Taught

45

REFERENCES:

- | | |
|---|---|
| 1 | Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006. |
| 2 | Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2007. |
| 3 | Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006 |
| 4 | MacLachlan M. and Gallagher P. Enabling Technologies - Body Image and Body Function, Churchill Livingstone, 2004. |
| 5 | Mann W.C. (ed). Smart Technology for Aging, Disability, and Independence - The State of The Science, Wiley, New Jersey, 2005. |
| 6 | Muzumdar A. Powered Upper Limb Prostheses - Control, Implementation and |


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COURSE OUTCOMES:

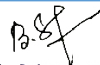
On completion of the course, the students will be able to

CO1:	Understand the principles of rehabilitation engineering, assistive technology, and the role of biomedical engineers in rehabilitation teams.
CO2:	Analyze and apply therapeutic exercise techniques including coordination, gait training, relaxation, strengthening, mobilization, and endurance exercises.
CO3:	Develop knowledge of communication management and virtual reality applications for rehabilitation, including aphasia treatment, hearing aids, and virtual reality-based rehabilitation systems.
CO4:	Design and evaluate orthotic and prosthetic devices, including functional electrical stimulation systems, hybrid assistive systems, and software-based modeling of prostheses and orthoses.
CO5:	Explain the basic concepts of orthotic and prosthetic devices, including their classification, principles, applications, lower-limb orthoses (FO, AFO, KAFO, HKAFO), prosthetic systems, Functional Electrical Stimulation (FES), and Hybrid Assistive Systems (HAS) used in rehabilitation and mobility restoration.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482- ME- BME
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Semester II- Professional Elective Courses

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE02	Medical Optics	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand various optical properties of tissue and gain the knowledge of photonics instruments, practical applications of optics related to diagnostics applications. To acquire knowledge about therapeutic and surgical applications of lasers in medical fields and gain the knowledge of fiber optic sensors used in medical application					

Unit-I	Optical Properties of The Tissues :	(9)
Optical properties of tissue- melanin, bilirubin, tissue and their spectrum, optical characteristics of constituents of blood – RBC, hemoglobin properties, plasma, oxygenated and deoxygenated hemoglobin, Laser tissue Interaction-Chemical, Thermal, Electromechanical. Photo ablative processes. Laser safety procedures.		
Unit-II	Instrumentation In Photonics:	(9)
Review of basic properties of light – Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, scattering and emission measurements. Optical sources – high pressure arc lamps, LEDs, Medical Lasers. Optical filters. Optical detectors - Time resolved and phase resolved detectors, optical tweezers.		
Unit-III	Diagnostic Applications:	(9)
Wood's lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, FRAP, NIRS- Application, X-Ray Diagnostic Techniques, Speckle Correlometry, Near-Field Imaging in Biological and Biomedical Applications.		
Unit-IV	Therapeutic And Surgical Applications of Light:	(9)
Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT - Bio stimulation effect – applications. Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology, neurology, orthopedics, gastroenterology.		
Unit-V	Fiber Optic Sensors and Applications:	(9)
Light transport in the optical fiber - Total internal reflection, Numerical aperture, Angle of acceptance. losses in fiber, Optical sensors based on polarization, magnetic sensors, medical applications of fiber optic sensors in measuring temperature, pressure, flow and chemical activities.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		


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Total No of Periods to be Taught	45
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REFERENCES:	
1	Mark E. Brezinski, "Optical Coherence Tomography: Principles and applications", Academic Press, 2006.
2	Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007.
3	Paras N. Prasad, "Introduction to Bio photonics, A. John Wiley and sons, Inc Publications, 2003.
4	R. Splinter and B.A. Hooper, "An Introduction to Biomedical Optics", Taylor and Francis, 2007.
5	Tuan Vo Dinh, "Biomedical photonics - Handbook", CRC Press LLC, 2003. .

COURSE OUTCOMES: On completion of the course, the students will be able to	
CO1:	Understand optical properties of tissues, including absorption, scattering, and laser-tissue interactions.
CO2:	Analyze photonics instrumentation for diagnostics, including optical sources, detectors, and measurement techniques.
CO3:	Apply optical techniques for medical diagnostics using imaging methods like OCT, Raman imaging, FLIM, and NIRS.
CO4:	Evaluate therapeutic and surgical applications of light, including phototherapy, photodynamic therapy, and laser-based interventions.
CO5:	Apply the principles of optical fiber communication and fiber optic sensors .

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME -BME
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Professional Elective Courses

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE03	Human Assist Devices	L	T	P	C	100
		3	0	0	3	
Course Objectives	To know the principle and design of Heart lung machine, artificial heart and various cardiac assist devices. To study implantation of artificial kidney, prosthetic and orthotic devices for the disability and Gain knowledge in respiratory devices and hearing aids					

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, Mock test setup for assessing its Functions.		
Unit-II	Cardiac Assist Devices:	(9)
Synchronous Counter pulsation, assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra-Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardiac Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.		
Unit-III	Artificial Kidney:	(9)
Indication and Principle of Hemodialysis, Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.		
Unit-IV	Prosthetic AND Orthotic Devices:	(9)
Spinal orthotics and Prosthesis, Splint - Static and Dynamic. Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Intelligent prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices, Transcutaneous electrical nerve stimulator.		
Unit-V	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, Construction and Functional Characteristics.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Andreas. F. Vonracum, Handbook of biomaterial evaluation, Mc-Millan publishers, 1980
2	Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey,1982
3	Gray E Wnek, Gray L Browlin - Encyclopedia of Biomaterials and Biomedical Engineering -Marcel Dekker Inc New York 2004
4	John. G . Webster - Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2008
5	Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
6	Gerr . M. Craddock " Assistive Technology-Shaping the future", IOS Press, 1st edition, 2003.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understand the principles, design, and functioning of heart-lung machines and artificial hearts.
CO2:	Analyze cardiac assist devices, prosthetic cardiac valves, and implantable biomaterials for cardiovascular support.
CO3:	Evaluate artificial kidney systems, prosthetic and orthotic devices, and functional electrical stimulation systems for rehabilitation.
CO4:	Understand respiratory and hearing assist devices, including ventilators, IPPB units, and hearing aids, and their applications in patient care.
CO5:	Apply the principles of ventilators, respiratory monitoring systems, and hearing aids to understand their construction, operation, and clinical applications in patient care.

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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Professional Elective Courses

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE04	Micro and Nano Fluids	L	T	P	C	100
		3	0	0	3	
Course Objectives	To develop a broad and deep understanding of transport phenomena at the micro/nanoscale, understand major applications of micro/nanofluidics and major methods to fabricate micro/nanofluidic devices. Design and test new micro/nanofluidic devices for certain applications and the process of nano fluid preparation					

Unit-I	Introduction to Microfluidics :	(9)
Microfluidics Versus Traditional Fluidics, properties of fluids, classification of fluids, pressure driven flow, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel - surface tension, contact angle and Electro Wetting, Navier Stokes equation. Electro kinetic phenomena- Electro-Osmosis, Di electrophoresis, Electric double layer, Debye length, capillary flow, flow through porous media, Diffusion.		
Unit-II	Fabrication Techniques :	(9)
Polymer-Based Micromachining Techniques- Polymeric Surface Micromachining, Soft Lithography, Micro stereo Lithography, Micro molding., Hot embossing, Fluid interconnections.		
Unit-III	Components:	(9)
Design considerations and applications - Micromixers, Microvalves, Micropumps, Microchannels, Microflow sensors. Droplet generators - Microparticle separator - Principles of separation and sorting of microparticles. Practical aspects of testing flow through microfluidic channels, Digital Microfluidics. Immunosensors - Nucleic acid sensors, DNA amplification platforms.		
Unit-IV	Diagnostic Applications:	(9)
In vitro diagnostics, Point - of - care diagnostics, Controlled drug delivery using microfluidic devices, Microneedles for drug delivery and monitoring, Microfluidic devices for cell manipulation, single-cell trapping, automated micro-robotic injection, Microfluidic devices for stem cell analysis and genetic analysis, paper-based microfluidic biomedical devices.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Tabeling, P., "Introduction to microfluidics," Oxford University Press Inc., 2005.
2	Osterbrock and van den Berg, "Lab-on-a-chip: Miniaturized Systems for (Bio)Chemical Analysis and Synthesis." Elsevier, 2003.
3	Gescheke et al, "Microsystems Engineering of Lab-on-a-Chip Devices". Wiley, 2004.
4	Nguyen, N. T., Wereley, S. T., "Fundamentals and Applications of Microfluidics," Artech house Inc., 2002.
5	Madou, M. J., "Manufacturing Techniques for Microfabrication and Nanotechnology," Vol. 2, CRC Press, Boca Raton, FL, 2011.
6	Kirby, B. J., "Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices," Cambridge University Press, 2010.
7	Chakraborty, S., "Microfluidics and microfabrication," Springer, New York, NY, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to

CO1:	Fundamentals of micro/nano fluidics, flow in micro/nano channels, electro kinetic phenomena
CO2:	Fabrication techniques and design considerations of micro/nanofluidic devices
CO3:	Design, analysis, and operation of microfluidic components and droplet/microparticle systems
CO4:	Biomedical applications of micro/nanofluidics, diagnostic and experimental case studies
CO5:	Apply microfluidic technologies for in vitro diagnostics, point-of-care testing, controlled drug delivery, cell manipulation, stem cell analysis, genetic analysis, and biomedical monitoring applications.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	2	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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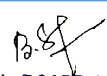


Department	Biomedical Engineering	Programme Code & Name	482- ME -BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE05	Medical Device Standards and Regulation	L	T	P	C	100
		3	0	0	3	
Course Objectives	Understand standards and safety aspects of medical devices, hospital safety standards and maintenance and medical device regulations. Describe medical device risk assessment and regulatory requirements.					

Unit-I	Standards and safety:	(9)
Quality management system for medical devices (iso 9001 and iso13485), safety and standardization for risk management (iso 14971), european standard conformity (ce marking), fda guidelines for medical devices approval and classification based on risk assessment.		
Unit-II	Hospital safety standards:	(9)
life safety standards- protecting hospital and occupants from fire, smoke, and heat, providing and maintaining fire alarm systems, systems for extinguishing fires environment of care standards- minimizing ec risks, smoking prohibitions, managing hazardous material and waste, maintaining fire safety equipment, features, testing, maintaining, and inspecting medical equipment..		
Unit-III	Medical equipment essential requirements:	(9)
General requirements for basic safety & essential performance of medical equipment, iec 60601 standards- base standard- general requirement of electrical medical devices, collateral standards- emc radiation protection & programmable medical device system, particular standards-type of medical device.		
Unit-IV	Medical device regulation:	(9)
Medical device and in vitro diagnostics: introduction & types of devices including combination devices. Medical device rules, 2017: implications on medical devices. Classification of medical devices. Labelling of medical devices and in vitro diagnostics.		
Unit-V	Medical device risk assessment :	(9)
Inspection of medical device and ivd establishments. Iso 14971 (medical devices: application of risk management to medical devices). Regulatory requirements of biocompatibility of medical devices and iso 10993. Clinical investigation of medical devices, regulation of investigational medical devices. Medical device regulation: international practices.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		


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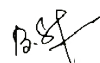


Total No of Periods to be Taught	45
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REFERENCES:	
1	Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo, Medical Devices Regulations, Standards and Practice, Wood head Publishing, 1 st Edition, 2015.
2	Joint Commission International Accreditation Standards for Hospitals, Joint Commission International, 6 th Edition, 2017.
3	Joseph D. Nally (ed.), Good Manufacturing Practices for Pharmaceuticals, CRC Press sixth edition, 2007
4	https://nptel.ac.in/courses/127106136
5	MDR17, Regulation of Medical Devices,

COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Quality management systems and standards ISO 9001, ISO 13485, ISO 14971)
CO2:	Hospital safety standards, life safety, and equipment maintenance
CO3:	Medical device regulations, classification, CE marking, FDA guidelines
CO4:	Risk assessment, biocompatibility testing, clinical investigation, international regulatory practices
CO5:	Explain the inspection of medical device and IVD establishments, ISO 14971 risk management, ISO 10993 biocompatibility requirements,

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	3	-	3	3	2
CO3	3	-	3	3	3
CO4	-	3	-	3	3
CO5	3	3	3	3	3
Avg.	2.4	1.6	2.2	3	2.6
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Mecheri, Salem Dt-636453, Tamilnadu



Department	Biomedical Engineering	Programme Code & Name	482- ME -BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE06	Tele Health Technology	L	T	P	C	100
		3	0	0	3	
Course Objectives	To teach the key principles for telemedicine and telemedical technology, telemedical standards. design and develop m-Health platforms for telemedical applications. Diagnosis the applications of health care sectors					

Unit-I	Telemedicine and Health :	(9)
History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.		
Unit-II	Telemedical Technology:	(9)
Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data –local and centralized		
Unit-III	Telemedical Standards Security and Legal Issues:	(9)
Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Realtime Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentiality of medical records and access control, Cyber laws related to telemedicine.		
Unit-IV	m-Health and Telemedicine:	(9)


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Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers - m- Health technology and communication infrastructure - Healthcare Apps - m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support - m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials		
Unit-V	Telemedical Applications:	(9)
Telemedicine access to health care services - health education and self-care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services- health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	

REFERENCES:	
1	Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.
2	Teresa L. Thompson, Roxanne Parrott, Jon F. Nussbaum, The Routledge Handbook of Health Communication, Routledge, 2011.
3	David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008
4	Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006
5	Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 2011.
6	Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0).
7	Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199- 413-3), 2002.
8	Magnuson, J.A., Fu, Jr., Paul C. (Eds.), Public Health Informatics and Information systems, ISBN 978-1-4471-4237-9, Springer, 2014
9	Simpson, W. 2006. Video over IP. A practical guide to technology and applications.


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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Principles, evolution, ethics, and regulations of telemedicine
CO2:	Telemedical technologies, multimedia communication, network and mobile infrastructure
CO3:	Telemedical standards, data security, encryption, interoperability protocols
CO4:	Design and implementation of m-Health platforms and telemedicine applications
CO5:	Apply telemedicine technologies for healthcare delivery, health education, self-care, robotic and telesurgery,

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	-	3	2
CO2	3	-	3	3	2
CO3	-	3	-	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	1.2	1	1.8	3	2.0

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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Professional Elective Courses

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE07	Medical Robotics	L	T	P	C	100
		3	0	0	3	
Course Objectives	To explain the basic concepts of robots and types of robots and design of manipulators, actuators and grippers. To impart knowledge on various types of sensors and power sources and explore various applications of Robots in Medicine and impart knowledge on wearable robots					

Unit-I	Introduction To Robotics :	(9)
Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization. Sensors and Actuators Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models.		
Unit-II	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. Navigation and Treatment Planning -Variable speed arrangements, Path determination - Machinery vision, Ranging - Laser - Acoustic, Magnetic, fiber optic and Tactile sensor.		
Unit-III	Surgical Robots:	(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 Nanorobotics. Case Study.		
Unit-IV	Rehabilitation and Assistive Robots:	(9)
Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons - Design considerations, Hybrid assistive limb. Case Study.		
Unit-V	Wearable Robots:	(9)


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Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human- robot cognitive interaction (cHRI), Human-robot physical interaction (pHRI), Wearable Robotic Communication.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Total No of Periods to be Taught

45

REFERENCES:

1	Nagrath and Mittal, "Robotics and Control," Tata McGraw Hill, First edition, 2003
2	Spong and Vidyasagar, "Robot Dynamics and Control," John Wiley and Sons, First edition, 2008
3	Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control," sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
4	Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5	Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6	Sashi S Kombu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7	Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8	Howie Chose, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations," Prentice Hall of India, First edition, 2005
9	Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10	Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
11	Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12	Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015


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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Basics of robots, configurations, DOF, workspace, robot subsystems
CO2:	Design of manipulators, actuators, grippers, Design of manipulators, actuators, grippers,
CO3:	Applications of medical robots: surgical, rehabilitation, assistive systems
CO4:	Wearable robotics, human-robot interaction, AR integration, soft robots
CO5:	Study about Wearable Robots

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	2
CO2	-	3	3	3	3
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.8	1	1.8	3	2.8
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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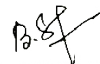


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Elective Courses

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE08	Wearable Technologies	L	T	P	C	100
		3	0	0	3	
Course Objectives	Identify the motivation, guiding principles, and challenges of Wearable Computing and develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.					

Unit-I	Introduction :	(9)
Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social aspects of wearability and interaction: Social interpretation of Aesthetics - Case study: Google glass - Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display - Wearable sensorimotor enhancer.		
Unit-II	Wearable Sensors:	(9)
Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors, Biochemical sensors		
Unit-III	Flexible Electronics:	(9)
Introduction, Thin-film transistors: Materials and Technologies, Review of Semi-conductors in flexible electronics - Low-power Integrated Circuit Design for Bio-potential sensing: Analog circuit design techniques - Low- power design for ADCs - Digital circuit design techniques - Architectural design for low-power bio- potential acquisition, Practical considerations.		
Unit-IV	Energy Harvesting Systems:	(9)
Energy harvesting from human body: Temperature gradient, Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues, Future considerations.		
Unit-V	Monitoring Physical and Physiological Parameters:	(9)
Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual- mode tongue drive system.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2	Tom Bruno , "Wearable Technology: Smart Watches to Google Glass for Libraries", Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
3	Raymond Tong , "Wearable Technology in Medicine and Health Care", Academic Press, USA, 2018.
4	Haider Raad , "The Wearable Technology Handbook", United Scholars Publication, USA, 2017.
5	Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
6	Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2021.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Fundamentals of wearable computing: attributes, challenges, social aspects, wearable haptics, and case studies
CO2:	Wearable sensors, flexible electronics, and low- power bio-potential acquisition circuit design
CO3:	Energy harvesting techniques and power management strategies for wearable systems
CO4:	Monitoring physical and physiological parameters and design of wearable sensors for biomedical applications
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	3	-	3	2
CO3	3	-	2	2	2
CO4	-	-	3	3	3
CO5	-	3	3	3	3
Avg.	1.2	1.2	1.8	2.2	2.0

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy

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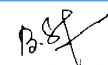


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE09	Brain Computer Interface	L	T	P	C	100
		3	0	0	3	
Course Objectives	The objective of this course is to enable the student to understand the basic concepts of brain computer interface and explore the various signal acquisition methods, signal processing methods used in BCI. Understand the various machine learning methods of BCI and Learn the various applications of BCI.					

Unit-I	Introduction to BCI :	(9)
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, MEG, fMRI.		
Unit-II	Brain Activation :	(9)
Brain activation patterns - Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials - P300 and Auditory Evoked Potentials.		
Unit-III	Feature Extraction Methods:	(9)
Data Processing - Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization.		
Unit-IV	Machine Learning Methods for BCI :	(9)
Classification techniques -Binary classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Support vector machine, Graph theoretical functional connectivity analysis.		
Unit-V	Applications of BCI s:	(9)
Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Ethics of Brain Computer Interfacing.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Rajesh P.N. Rao, Brain-Computer Interfacing: An Introduction, Cambridge University Press, 1st Edition, 2013.
2	Ella Hassianien A and Azar A.T Ed, Brain-Computer Interfaces Current Trends and Applications, Springer, 2015.
3	Jonathan Wolpaw and Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and practice, Oxford University Press, USA, 1st Edition, 2012.
4	Bernhard Graimann, Brendan Allison and Gert Pfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010
5	Ali Bashashati, Mehrdad Fatourehchi, Rabab K Ward and Gary E Birch, A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals, Journal of Neural Engineering, Vol.4, 2007, pp.32-57.
6	Arnon Kohen, Biomedical Signal Processing, Vol I and II, CRC Press Inc, Boca Raton, Florida.
7	Bishop C.M., Neural networks for Pattern Recognition, Oxford, Clarendon Press, 1995.
8	Andrew Webb, Statistical Pattern Recognition, Wiley International, 2nd Edition,

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the fundamentals of Brain Computer Interface systems including brain physiology, BCI types, and signal acquisition methods (EEG, MEG, fMRI)
CO2:	Analyze brain activation patterns and apply signal processing and feature extraction techniques for BCI applications
CO3:	Apply machine learning and classification methods for BCI signal interpretation and performance evaluation
CO4:	Explain the fundamentals of Brain Computer Interface systems including brain physiology, BCI types, and signal acquisition methods (EEG, MEG, fMRI)
CO5:	


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Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	3	2
CO3	-	3	3	3	3
CO4	3	-	3	3	3
CO5	3	-	-	3	3
Avg.	1.2	1.2	1.2	2.4	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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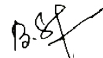


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE10	Wavelet Transforms and Applications	L	T	P	C	100
		3	0	0	3	
Course Objectives	To study the basics of signal representation and Fourier theory, Multi Resolution Analysis and Wavelet concepts in both continuous and discrete domain. To understand the design of wavelets using Lifting scheme and applications of Wavelet transform					

Unit-I	Fundamentals :	(9)
-Vector Spaces - Properties- Dot Product - Basis - Dimension, Orthogonality and Orthonormality - Relationship Between Vectors and Signals - Signal Spaces -Concept of Convergence - Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion, Fourier transform, Short time Fourier transform, Time- frequency analysis.		
Unit-II	Multi Resolution Analysis :	(9)
Definition of Multi Resolution Analysis (MRA) - Haar Basis - Construction of General Orthonormal MRA - Wavelet Basis for MRA - Continuous Time MRA Interpretation for the DTWT - Discrete Time MRA - Basis Functions for the DTWT - PRQMF Filter Banks.		
Unit-III	Continuous Wavelet Transforms:	(9)
Wavelet Transform - Definition and Properties -Concept of Scale and its Relation with Frequency - Continuous Wavelet Transform (CWT)-Scaling Function and Wavelet Functions(Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)- Tiling of Time - Scale Plane for CWT.		
Unit-IV	Discrete Wavelet Transform:	(9)
Filter Bank and Sub Band Coding Principles - Wavelet Filters - Inverse DWT Computation by Filter Banks - Basic Properties of Filter Coefficients - Choice of Wavelet Function Coefficients - Derivations of Daubechies Wavelets - Mallat's Algorithm for DWT -Multi Band Wavelet Transforms Lifting Scheme- Wavelet Transform Using Polyphase Matrix Factorization - Geometrical Foundations of Lifting Scheme - Lifting Scheme in Z -Domain.		
Unit-V	Applications :	(9)


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Wavelet methods for signal processing- Adaptive wavelet techniques in signal acquisition, Detection of signal changes, analysis and classification of audio signals using CWT, Signal and Image compression Techniques: EZW-SPIHT Coding- Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection. Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Digital Communication and Multicarrier Modulation, Trans multiplexers.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Total No of Periods to be Taught

45

REFERENCES:

1	Rao R M and A S Bopardikar, —Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2012.
2	L.PrasadS.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRCPress, 1997.
3	J. C. Goswami and A. K. Chan, Fundamentals of wavelets: Theory, Algorithms and Applications, Wiley Interscience Publication, John Wiley & Sons Inc., 2011.
4	M. Vetterli, J. Kovacevic, Wavelets and sub band coding, Prentice Hall Inc, 2013.
5	Stephen G. Mallat, A wavelet tour of signal processing, 2 nd Edition Academic Press, 2009.
6	Soman K P and Ramachandran K I, Insight into Wavelets From Theory to practice, Prentice Hall, 2010

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain fundamentals of signal spaces, Fourier theory, and time-frequency analysis concepts
CO2:	Analyze Multi Resolution Analysis (MRA), Continuous and Discrete Wavelet Transforms, and lifting schemes
CO3:	Design and implement wavelet transforms using filter banks and lifting schemes for signal processing applications
CO4:	Apply wavelet techniques for signal and image processing applications such as denoising, compression, detection, and adaptive filtering using software tools
CO5:	


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Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	3	-	3	2
CO3	-	-	3	3	2
CO4	3	3	3	3	3
CO5	3	-	-	3	3
Avg.	1.8	1.2	1.2	2.4	2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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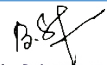


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE11	Hospital Planning Organization and Management	L	T	P	C	100
		3	0	0	3	
Course Objectives	With an objective of imbibing a professional approach amongst students towards hospital management and encompasses management principles, staffing and marketing processes, discussing their significance and role in the effective and efficient management of health care organizations.					

Unit-I	Forms of Organisation :	(9)
Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management.		
Unit-II	Hospital Administration and Management :	(9)
Healthcare and Management, Functions of management, Healthcare delivery systems in India and globally, public vs private healthcare, Levels of care (primary, secondary, tertiary) Challenges in Hospital Administration, Hospital Planning, Design, and layout of hospitals. Equipment Planning, Facility and biomedical equipment planning, Legal Aspects of Hospital Administration, Strategic planning.		
Unit-III	Staffing:	(9)
Staffing pattern in hospitals, Selection, Recruiting process, Training of staff, Organizational structures, Career development.		
Unit-IV	Marketing and Management:	(9)
Basic concepts marketing, Principles of social marketing, Social marketing in the health sector, Consumer behavior and research health, Advertising in Health Sector, Relevance of e-marketing of Health care services.		
Unit-V	Hospital Technical Support Services :	(9)
HIS Technical Support, Management Decisions and Related Information Requirement, Administrative Information Systems, Support Service Technical Information Systems, Medical Transcription, Medical Records Department, Network Support, IT Infrastructure Support Medical Device Support, the Importance of Technical Support.		


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Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Total No of Periods to be Taught	45

REFERENCES:	
1	Goyal R.C., Human Resource Management in Hospital, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2	Nauhria R.N. and Rajnish Prakash, Management & systems, New Delhi Wheeler publishing, 1995.
3	Koontz, Essentials of Management, McGraw Hill, 1995.
4	G. D. Kunders Hospitals: Facilities Planning and Management, Tata McGrawHill Education, New Delhi, 2004
5	Syed Amin Tabish, Hospitals & Nursing Homes: Planning, Organisations & Management, Jaypee Brothers Medical Publishers (P) Limited, 2003

COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Explain principles of management, forms of organization, and healthcare delivery systems in India and globally
CO2:	Analyze hospital planning, administration, equipment planning, legal aspects, and strategic management in healthcare organizations
CO3:	Apply staffing, marketing, and organizational management concepts in hospital settings
CO4:	Develop a comprehensive hospital plan incorporating infrastructure, biomedical equipment planning, and technical support services
CO5:	

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	2	2	2
CO3	-	-	3	1	2
CO4	-	-	3	2	3
CO5	-	-	3	2	3
Avg.	-	0.6	2.2	1.4	2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE12	Human Resource Management in Hospitals	L	T	P	C	100
		3	0	0	3	
Course Objectives	This subject acquaints the students with major functions of HRM aligned with the business strategy. The subject encompasses the concept of best fit employee, training & executive development, sustaining employee interest and performance appraisal					

Unit-I	Perspectives of Human Resource Management :	(9)
Evolution of Human Resource Management - Importance of Human factor, Objectives of Human Resource Management-Human Resource Policies - Need for HRD/HRM in Healthcare Organization - Computer Applications in Human Resource Management.		
Unit-II	The Concept of Best Fit Employee :	(9)
Organizational Job Design - job description - job analysis - job rotation-job evaluation- Man- power planning- Importance of Human Resource Planning, Forecasting of Human Resource Requirements - Selection procedures - test, Validation, Interviews, Recruitment, Medical Examination.		
Unit-III	Training & Executive Development:	(9)
Types of Training methods and their benefits - Executive development Programme - common practices - Benefits, self-development - knowledge Management.		
Unit-IV	Sustaining Employee Interest:	(9)
Wage and Salary Administration - the concept of incentives and its operational implications - Participative decision making - Concept of Collective Bargaining - Compensation plans - Rewards - Motivation - Theories of motivation - Grievances and redressal methods.		
Unit-V	Performance Appraisal :	(9)
Importance of Performance Appraisal - Methods of Performance Evaluation, - Traditional methods - Modern methods - Feedback - Promotion - Demotion - transfer. Implications of jobs change. The control process, Methods and Requirements of an Effective control system.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		


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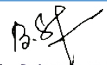


Total No of Periods to be Taught	45
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REFERENCES:	
1	R.C.Goyal, Human Resource Management in Hospitals, Prentice Hall of India, 2000.
2	Mamoria C.B. and Mamoria S. Personnel Management, Himalaya Publishing Company, 1997
3	Decenzo and Robbins, Human Resource Management, Wiley & Sons, Singapore, 1999.
4	D. K. Sharma, R. C. Goyal, Hospital administration and human resource management, PHI Learning Pvt. Ltd., 2013
5	Walter J. Flynn (Author), Robert L. Mathis (Author), John H. Jackson, Healthcare

COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Explain principles, evolution, and importance of Human Resource Management (HRM) in healthcare organizations including HR policies and computer applications
CO2:	Apply job design, manpower planning, recruitment, and selection procedures for achieving best fit employees in hospitals
CO3:	Analyze training, executive development programs, motivation theories, compensation plans, and participative management practices
CO4:	Evaluate performance appraisal methods and control systems for effective human resource management in hospitals
CO5:	

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	2	1	2
CO3	-	2	-	1	2
CO4	-	3	2	1	2
CO5	-	3	2	1	2
Avg.	-	2.2	1.2	0.8	1.6
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Semester- II

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE13	Health Policy and Equipment Management	L	T	P	C	100
		3	0	0	3	
Course Objectives	To expose the students for planning and operation of hospitals in a detailed manner which will include all facts of hospital planning activities covering every department that is involved both in clinical care as well as supportive services and introduce the equipment maintenance.					

Unit-I	Health System :	(9)
Health organization of the country, the state and cities, health financial system, teaching cum research hospitals, General Hospital, PHC reference system, Ambulatory Care		
Unit-II	National Health Policy:	(9)
Need for evaluating a health policy, need for providing primary health care, health education, health insurance, health legislation, inter-sectoral cooperation.		
Unit-III	Equipment Maintenance Management :	(9)
Organizing the maintenance operation, biomedical equipment procurement procedure, proper selection, compatibility, testing and installation, purchase and contract procedure, trained medical staff, on the proper use of the equipment and operating instructions. Maintenance job planning, preventive maintenance, maintenance budgeting, contract maintenance.		
Unit-IV	Logistic Support & Reliability:	(9)
Maintenance equipment and Tools, failure analysis, spare parts, and maintenance materials. Reliability fundamentals.		
Unit-V	EMI In Hospital Equipment:	(9)
Principles of EMI, computation of EMI, Method of suppressing and isolating the unit from interference.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45
REFERENCES:		
1	Antony Kelly, 'Maintenance Planning & control' Butterworth, London 1984.	


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2	Binseng Wang, Medical Equipment Maintenance: Management and Oversight, Morgan & Claypool Publishers, 2012
3	Hans Pleiff veradamman (ed) `Hospital Engineering in developing countries, GTZ report Eschborn, 1986.
4	Medical Equipment Management, Keith Willson, Keith Ison, Slavik Tabakov CRC Press, 2013
5	R.C.Goyal `Human Resource Management in Hospitals' Prentice Hall of India, New

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the structure of health systems, national health policy, health financing, and primary healthcare delivery mechanisms
CO2:	Analyze health policies, healthcare legislation, insurance systems, and inter-sectoral cooperation in hospital administration
CO3:	Apply principles of biomedical equipment procurement, maintenance management, preventive maintenance, budgeting, and contract management
CO4:	Evaluate reliability, logistics support systems, EMI issues, and failure analysis in hospital equipment management
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	1	2
CO3	-	-	3	3	3
CO4	-	3	-	3	3
CO5	-	3	-	3	3
Avg.	-	1.2	0.6	2.0	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE14	Hospital Waste Management	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand the significance of infections, biomedical waste and its proper disposal and learn about the controls applied to waste management.					

Unit-I	Introduction :	(9)
Medical waste stream, different types of medical waste, its source of origin. Waste management elements - categories of bio-medical waste, different colour codes and symbols -rules and regulation includes state and national level bodies.		
Unit-II	Principles of Sterilization :	(9)
Disease and its mode of transmission - Disinfection methods- concept and mechanism - physical sterilization and chemical sterilization - Large scale autoclave - Microwave (Non-burn treatment technology).		
Unit-III	Disposal of Waste :	(9)
Disposal methods - Incinerator and its types-hazardous waste, radioactive waste, liquid waste destruction - landfill and rules governing landfill.		
Unit-IV	Controls Applied to Waste Management :	(9)
Air pollution and emission control, rules governing pollution, instrumentation and monitoring, emission filters and its types, crematories- gas emission control device.		
Unit-V	Environmental Safety, Risks & Public Issues:	(9)
Risk management in hospitals - Environment issues in hospitals - Risk analysis.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	C.R. BRUNNER, Medical Waste
2	C.R. BRUNNER, Incentrated Consultant in Corporated Incentrated System Hand Book, Virginia.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain biomedical waste categories, regulations, color coding, and legal frameworks governing hospital waste management
CO2:	Analyze principles of sterilization, disinfection methods, and disease transmission control in healthcare settings
CO3:	Evaluate waste disposal techniques including incineration, landfill management, hazardous and radioactive waste treatment
CO4:	Assess environmental safety, air pollution control measures, emission monitoring systems, and risk management strategies in hospitals
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	2	2
CO3	-	3	2	2	2
CO4	-	3	-	2	2
CO5	-	3	-	2	2
Avg.	1.8	-	1.2	2.2	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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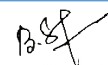


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE15	Quality assurance and Patients Safety Standards in hospitals	L	T	P	C	100
		3	0	0	3	
Course Objectives	To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care and aware of the role of the biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety.					

Unit-I	Standardization of Quality Medical Care in Hospitals:	(9)
Define Quality- Need for Standardization & Quality Management, TQM in Health care organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment.		
Unit-II	Regulatory Requirement for Health Care :	(9)
FDA regulations, Accreditation for hospitals- JCI, NABH and NABL, Other regulatory Codes.		
Unit-III	Hospital Safety :	(9)
Security & Safety of Hospital -Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste.		
Unit-IV	Electrical & Fire Safety:	(9)
Sources of shocks, macro & micro shocks -Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital.		
Unit-V	Assessing Quality Health Care:	(9)
Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop's – Patient Orientation for Total Patient Satisfaction. 5S technique		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the principles of quality management, standardization, and total quality management (TQM) in healthcare
CO2:	Analyze regulatory requirements, hospital accreditation (JCI, NABH, NABL), and compliance standards in healthcare
CO3:	Evaluate hospital safety, radiation safety, electrical and fire hazards, and implement safety precautions
CO4:	Apply patient safety and quality assessment tools (SOPs, 5S, Six Sigma) to improve hospital services and ensure patient satisfaction
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	2	2
CO3	-	3	2	2	2
CO4	-	-	3	2	2
CO5	-	-	3	2	2
Avg.	-	1.2	1.6	1.6	1.6
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE16	Genetic Algorithms and Fuzzy Logics	L	T	P	C	100
		3	0	0	3	
Course Objectives	To provide basic knowledge about the fundamentals of genetic algorithm familiarizewiththeantcolonyandparticleswamoptimizationtechniques, basics of fuzzy logic and its applications and neuro fuzzy system and fuzzy logic controller					

Unit-I	Genetic Algorithms :	(9)
Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, Applications of GA.		
Unit-II	Other Optimization Techniques :	(9)
Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Particle Swarm Optimization: Introduction– Principles of bird flocking and fish schooling– Evolution of PSO – Operating principles – PSO Algorithm.		
Unit-III	Fuzzy Logic :	(9)
Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Operations on Fuzzy Sets, Fuzzy Arithmetic, Compliment, Intersections, Unions, Fuzzy Relation.		
Unit-IV	Fuzzy Rule Based System :	(9)
Linguistic Hedges. Rule based system, Fuzzification and Defuzzification, Fuzzy inference systems - Mamdani and Sugeno model, Fuzzy clustering - fuzzy C-means algorithm - fuzzy control method- fuzzy decision making.		
Unit-V	Advances and Applications :	(9)
Case studies: Fuzzy logic control of Blood pressure during Anaesthesia, Fuzzy logic application to Biosignals and medical Image processing, Adaptive fuzzy system. Introduction to Neuro-fuzzy logic.		
Weightage: Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004.
2	David E. Goldberg, "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education, 2006
3	Kenneth A DeJong, "Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi, 2006
4	H.-J. Zimmermann, "Fuzzy Set Theory and its Applications", Springer Science+Business Media New York, 4th edition, 2001
5	Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2016

COURSE OUTCOMES:

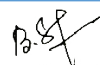
On completion of the course, the students will be able to

CO1:	Explain the fundamentals of Genetic Algorithms, optimization techniques, and terminology including operators, fitness function, and modeling
CO2:	Analyze Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO) principles and their applications
CO3:	Apply fuzzy logic concepts, classical vs fuzzy sets, membership functions, and fuzzy arithmetic to real-world problems
CO4:	Design and implement fuzzy rule-based systems, neuro-fuzzy models, and fuzzy logic applications in biomedical signals and medical image processing
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	2	3	2
CO3	-	-	3	3	3
CO4	3	-	-	3	3
CO5	3	-	-	3	3
Avg.	1.2	0.6	1	2.4	2.4

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE17	Tissue Engineering	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand basics of tissue engineering, cell mechanics and importance of biomaterials in tissue engineering. To understand the importance of stem cell in tissue engineering and tissue culture applications in human healthcare					

Unit-I	Introduction to Tissue Engineering :	(9)
History and scope of tissue engineering - Scientific and Social Challenges - Structure and organization of Tissues - Development of Tissue - Cell and Extracellular matrix interaction - Morphogenesis and Tissue Engineering - Cell Determination and Differentiation.		
Unit-II	Fundamentals of Cell Mechanisms :	(9)
Cell adhesion, Cell migration and Cell aggregation - Cell growth and Cell cycle. Cellular Interactions: Cell - Cell and Cell - Matrix. Control of Cell migration in Tissue Engineering -Cell delivery and Recirculation - Cell Culture in vitro - 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation.		
Unit-III	Biomaterials In Tissue Engineering :	(9)
Biological vs Nonbiological materials - Extra Cellular Matrix - Collagen, Chitin & Degradable and Nondegradable 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)
Hemopoetic 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 Applications :	(9)
Synthetic components - Artificial organs - Joints and dental prostheses - Connective Tissue Engineering - Cardiovascular Tissue Engineering - Neural Tissue Engineering - Cell and Drug Delivery systems.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press, 2nd edition 2009.
2	Robert P. Lanza, Robert Langer and Joseph Vacanti., Principles of Tissue Engineering, 2nd Edition, Academic press, Elsevier 2013.
3	Gary E Wnek, Gary L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering Marcel Dekker Inc New York, 2nd edition, 2008.
4	Sujata V. Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.
5	W. Mark Saltzman Tissue Engineering – Engineering Principles for Design of Replacement Organs and Tissue, Oxford University Press Inc. New York, 2004

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the fundamentals of tissue engineering, tissue structure, cell organization, and morphogenesis
CO2:	Analyze cell mechanisms including adhesion, migration, growth, interactions, and in vitro culture techniques for tissue engineering
CO3:	Apply knowledge of biomaterials, scaffolds, and cell-material interactions in tissue engineering applications
CO4:	Evaluate the role of stem cells and tissue engineering applications in regenerative medicine, artificial organs, and drug/cell delivery systems
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	2	2
CO3	-	-	3	3	2
CO4	3	3	-	3	3
CO5	3	3	-	3	3
Avg.	1.6	1.4	0.6	2.2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy					


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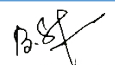


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE18	Embedded system and internet of things for Biomedical applications	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand hardware and software for ARM processor ARM processor and Building Blocks of Embedded Systems, provide information about sensor interfacing with Arduino, protocols for IoT and familiarize the student with the various applications in healthcare using IOT					

Unit-I	ARM Processor Hardware and Software:	(9)
Introduction to ARM Cortex-M Processors, Embedded Software Development, ARM architecture, ARM Instruction Set, Memory System, Exceptions and Interrupts. The C language: The evolution of C, An overview of C programming, C operators, identifiers, keywords and constants; The C preprocessor: commands, definition and replacement, File inclusion, Conditional compilation; storage classes, variable types, expressions and precedence, statements, functions.		
Unit-II	Embedded System Architecture - ARM Core :	(9)
ARM organization and implementation, The Thumb Instruction Set, Architectural Support for High-Level Languages. Introduction to Arduino Due; Arduino integrated development environment and programming.		
Unit-III	Sensor Interfacing with Arduino:	(9)
Basics of hardware design and functions of basic passive components-sensors and actuators, Arduino code - library file for sensor interfacing-construction of basic applications.		
Unit-IV	IOT: An Introduction:	(9)
Networked Embedded System types and overview, wireless communication standards-zigbee, Bluetooth & Wi-Fi. OSI & TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. IOT- understand what IOT is and discuss its application in health-care systems- Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness. Embedded web server: Basic introduction, its importance and role in IOT. Design of a simple embedded web server: understand the HTTP & HTML basics Overview of different IOT Cloud Services.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. McKinlay, "The 8051 microcontroller and embedded systems using assembly and C", 2nd Edition, Pearson, 2005.
2	Brian W. Kernighan, Dennis M. Ritchie, "The C programming language", 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1988.
3	Andrew Sloss, Dominic Symes, Chris Wright, ARM system developer's guide: designing and optimizing system software, Morgan Kaufmann, 2004.
4	S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, Vikas Publishing House, 2012.
5	R. S. Khandpur, "Printed Circuit Boards Design - Fabrication, Assembly and Testing", 1 st Edition, McGraw Hill Education, 2017.
6	Getting Started with Internet of Things- CunoPfister, 2011
7	Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010 24 Course

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain ARM processor architecture, embedded software, C programming concepts, and ARM instruction set
CO2:	Analyze embedded system architecture, Arduino programming, sensor interfacing, and actuator integration for biomedical applications
CO3:	Apply IoT protocols, wireless communication standards (Wi-Fi, Bluetooth, Zigbee), and embedded web server concepts in healthcare systems
CO4:	Design IoT-based healthcare applications such as wireless patient monitoring, wearable fitness devices, and IoT-enabled pulse oximeters
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	3	3	3
CO3	-	-	3	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	-	0.6	2.4	2.4	2.4

1 - Slight, 2 - Moderate, 3 -Substantial, BT - Bloom's Taxonomy


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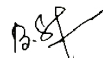


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE19	Medical Informatics	L	T	P	C	100
		3	0	0	3	
Course Objectives	To learn about operating systems and their uses, databases and their types, processing of data And recent trends in health informatics					

Unit-I	Operating System, Search Engine and Medical Standard:	(9)
Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet - Search Engine - Online Medical Resources - Electronic Health Records - Network - Evolution of Medical Standards - IEEE 11073 - HL7 - DICOM - IRMA - LOINC - HIPPA.		
Unit-II	Introduction to Medical Informatics:	(9)
-Introduction -Medical Informatics- Health Informatics - Structure of Medical Informatics - Functional capabilities of Hospital Information System - On-line services and Off - line services - Dialogue with the computer.		
Unit-III	Database and Health Informatics:	(9)
Data management - data life cycle - database technology - interfaces and implementation - biological databases and their uses - Database management system models, Basics of Structured Query Language (SQL). Genome projects, Clinical informatics, Nursing informatics, Public health informatics.		
Unit-IV	Medical Data Storage And Automation :	(9)
Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach, Normalization techniques for Data handling - 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		
Unit-V	Recent Trends In Medical Informatics :	(9)
Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment - Surgical simulation - Telemedicine - virtual Hospitals - Smart Medical Homes - Personalized e-health services - Biometrics - GRID and Cloud Computing in Medicine - Artificial Intelligence in health Informatics.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Orpita Bosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms" Oxford University press, 2007
2	Yi Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.
3	R.D.Lele,"Computers in medicine progress in medical informatics",Tata McGraw Hill Publishing Ltd, 2005
4	Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003
5	J.H. van Bommel and M.A. Musen. Handbook of Medical Informatics. Bohn Stafleu Van Loghum,. Springer
6	Robert E. Hoyt. Medical Informatics. Practical Guide for the Healthcare Professional. Published by: Lulu.com

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain operating systems, search engines, medical standards (IEEE 11073, HL7, DICOM, LOINC, HIPAA) and their applications in healthcare
CO2:	Analyze the structure and functional capabilities of medical and health informatics systems including Hospital Information Systems (HIS)
CO3:	Apply database management systems, SQL, data storage, modeling, normalization techniques, and medical automation in clinical environments
CO4:	Design and evaluate modern medical informatics solutions including telemedicine, virtual hospitals, smart medical homes, AI-based systems, and cloud/GRID computing applications
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	2	2	2
CO3	-	-	3	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	-	0.6	2.2	2.2	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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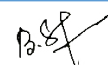


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE20	Pattern recognition Techniques and Applications	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand the fundamentals of Pattern recognition, various clustering techniques, feature extraction and selection and different classification models. To understand Fuzzy Pattern Classifiers and applications.					

Unit-I	Pattern Classifier :	(9)
Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation–Maximum Likelihood Estimation– Bayesian parameter Estimation – Problems with Bayes approach– Non Parametric techniques, Perceptron Algorithm -LMSE Algorithm- Pattern classification by distance functions – Minimum distance pattern classifier.		
Unit-II	Clustering :	(9)
Clustering Concept – Hierarchical Clustering Procedures – Partitional Clustering, k- means algorithm – Clustering of Large Data Sets – EM Algorithm – Grid Based Clustering– Density Based Clustering.		
Unit-III	Feature Extraction and Selection:	(9)
Entropy Minimization–KL Transforms–Regression- Linear, Non-linear and Logistic, Prediction, Feature Selection through Functions Approximation – Binary Feature Selection.		
Unit-IV	Hidden Markov Models and Supportvector Machine :	(9)
State Machines–Hidden Markov Models: Maximum Likelihood for the HMM, Forward-Backward Algorithm, Sum and Product Algorithm for the HMM, Extensions of the Hidden Markov Model – Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines.		
Unit-V	Recent Advances and Applications :	(9)
Elementary Neural Network for Pattern Recognition, Fuzzy pattern classifier, Application of PR in image segmentation, CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cellcytology classification		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45


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REFERENCES:

1	Andrew Webb, "Statistical Pattern Recognition", Arnold publishers, London, 2002
2	C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006
3	Earl Gose, Richard Johnsonbaugh Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1996
4	M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011
5	R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001
6	RobertJ. Schalkoff "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992
7	S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4 th Edition, Academic Press, 2008

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain fundamentals of pattern recognition, discriminant functions, supervised/unsupervised learning, parametric and non-parametric methods
CO2:	Analyze clustering techniques including hierarchical, k-means, EM, grid-based and density-based clustering for large datasets
CO3:	Apply feature extraction, selection, and dimensionality reduction techniques including KL transforms, regression, and approximation methods
CO4:	Design and evaluate classification models including Hidden Markov Models, SVMs, neural networks, and fuzzy classifiers for biomedical applications
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	2	3	2
CO3	-	-	3	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	-	0.6	1.2	2.4	2.2

1 - Slight, 2 - Moderate, 3 -Substantial, BT - Bloom's Taxonomy


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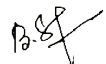


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE21	Data Analytics For Healthcare Technologies	L	T	P	C	100
		3	0	0	3	
Course Objectives	To explore the various forms of electronic healthcare information, techniques adopted to analyse health care data and natural language based analytics. To understand the predictive models for clinical data and gain knowledge health care analytics and its applications.					

Unit-I	Introduction :	(9)
Introduction to Healthcare Data Analytics - Electronic Health Records- Components of EHR- Coding Systems - Benefits of EHR-Barrier to Adopting HER - Challenges- Pheno typing Algorithms.		
Unit-II	Data Analysis :	(9)
Biomedical Image Analysis - Mining of Sensor Data in Healthcare- Biomedical Signal Analysis - Genomic Data Analysis for Personalized Medicine.		
Unit-III	Analytics:	(9)
Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical - Social Media Analytics for Healthcare.		
Unit-IV	Advanced Analytics :	(9)
Advanced Data Analytics for Healthcare - Review of Clinical Prediction Models- Temporal Data Mining for Healthcare Data-Visual Analytics for Healthcare - Predictive Models for Integrating Clinical and Genomic Data - Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Healthcare.		
Unit-V	Applications :	(9)
Applications and Practical Systems for Healthcare - Data Analytics for Pervasive Health - Fraud Detection in Healthcare-Data Analytics for Pharmaceutical Discoveries - Clinical Decision Support Systems-Computer- Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught		45
REFERENCES:		
1	Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015	


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2	Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.
3	Michael Berthold, David J.Hand, "Intelligent Data Analysis", Springer, 2007.
4	David J. Lubliner , "Biomedical Informatics: An Introduction to Information Systems and Software in Medicine and Health", CRC Press, Boca Raton, 2016

COURSE OUTCOMES:

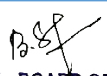
On completion of the course, the students will be able to

CO1:	Explain healthcare data types, electronic health records (EHR), coding systems, phenotyping algorithms, and challenges in data adoption
CO2:	Analyze biomedical signals, sensor data, genomic data, and image data for healthcare analytics
CO3:	Apply data mining, natural language processing (NLP), and advanced analytics techniques for clinical and social healthcare data
CO4:	Design predictive models, clinical decision support systems, and analytics solutions for pervasive healthcare, fraud detection, and biomedical imaging applications
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	3	3	2
CO3	-	-	3	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	-	0.6	2.4	2.4	2.2

1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy


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Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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Professional Electives

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE22	Mixed Reality	L	T	P	C	100
		3	0	2	4	
Course Objectives	Understand core concepts and components of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). Develop skills in AR/MR technologies and their applications using industry-standard tools. Explore interactive techniques and visual computation for immersive VR environments. Learn I/O interfaces and their integration in VR/MR systems for practical applications.					

Unit-I	Introduction to Virtual Reality:	(9)
Overview of Mixed Reality: Definitions and differences between VR, AR, and MR. Core VR Concepts: Virtual environment requirements, benefits, and historical context. 3D Computer Graphics: Virtual world space, perspective projection, stereographic imaging, basic 3D modeling, illumination models (Phong, Gouraud), shading algorithms, hidden surface removal.		
Unit-II	Interactive Techniques in Virtual Reality:	(9)
3D Interaction: Transition from 2D to 3D, 3D space curves, boundary representation. Geometrical Transformations: Frames of reference, modeling transformations, scaling, collision detection.		
Unit-III	VR Systems:	(9)
Components (virtual environment, computer environment, VR technology), interaction models, introduction to Unity/Unreal Engine for VR development..		
Unit-IV	Visual Computation in Virtual Reality:	(9)
Animation in VR: Linear/non-linear interpolation, object animation, shape in-betweening. Physical Simulation: Gravity, elastic collisions, projectiles, basic physics in VR using Unity/Unreal Engine physics engines. Real-Time Rendering: Optimization techniques for VR performance.		
Unit-V	Augmented and Mixed Reality:	(9)
AR/MR Fundamentals: Taxonomy, technology, differences between AR and VR, challenges. AR Techniques: Marker-based and marker-less tracking, visualization methods, ARKit/ ARCore integration. Applications: AR in education, mobile interfaces, interactive environments.		
Unit-VI	I/O Interfaces and Applications of VR/MR:	(9)


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Human Factors: Eye, ear, haptic feedback in VR/MR. Hardware: Sensors, head-mounted displays (HMDs), motion trackers, haptic devices. Software: VR/MR toolkits (Unity, Unreal Engine, Vuforia), VRML basics, application development. Industry Applications: VR/MR in gaming, film, education, medical visualization (e.g., surgery simulation).

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Total No of Periods to be Taught

45

REFERENCES:

1	Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley- IEEE Press, 2003/2006.
2	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, First Edition 2013.
3	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4	John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5	Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
6	Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2 nd Edition, 2006.
7	William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface,

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain core concepts of Virtual, Augmented, and Mixed Reality, 3D graphics, visualization, and immersive VR/MR environments
CO2:	Analyze 3D interaction techniques, geometrical transformations, animation, physical simulation, and real-time rendering in VR/MR systems
CO3:	Apply VR/MR software tools (Unity, Unreal Engine, Vuforia) and develop VR/AR/MR applications integrating human-computer interaction and I/O interfaces
CO4:	Design immersive VR/AR/MR applications for education, medical visualization, gaming, and other industry use cases considering human factors and usability
CO5:	


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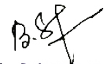
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Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	3	3	2
CO3	-	-	3	3	3
CO4	-	-	3	3	3
CO5	-	-	3	3	3
Avg.	-	0.6	2.4	2.4	2.2
1 - Slight, 2 - Moderate, 3 -Substantial , BT - Bloom's Taxonomy					


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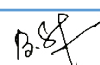


Department	Biomedical Engineering	Programme Code & Name	482-ME BME
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Professional Elective Courses (PE)

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
24BPE23	Medical Ethics and Standards	L	T	P	C	100
		3	0	0	3	
Course Objectives	Achieve familiarity with some basic ethical frameworks & understand how these ethical frameworks can help us to think through contemporary questions in medical ethics. Students will be able to know about the legal and ethical principles and apply these principles in health care settings & gain knowledge about the medical standards that are to be followed in hospitals.					

Unit-I	Introduction to 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		
Unit-II	Ethical Theories & Moral Principles :	(9)
Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles-Non- Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine.		
Unit-III	IHospital Accreditation Standards:	(9)
Accreditation- JCI Accreditation & its Policies. Patient Organization management standards.		
Unit-IV	Hospital Safety Standards:	(9)
Life Safety Standards- Protecting Occupants and Hospital from Fire, Smoke, and Heat, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.		
Unit-V	Medical Equipment Safety Standards:	(9)
General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards, Indian and International standards, ISO standards - Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.		
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%		
Total No of Periods to be Taught	45	


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REFERENCES:

1	Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007
2	Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
3	Robert M Veatch, The Basics of Bio Ethics, 3 rd Edition. Routledge, 2011.
4	Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2010
5	Joint Commission Accreditation Standards for Hospitals, 6 th Edition 2018.
6	Ben Mephram, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2008.
7	Nils Hoppe and Jose Miola - Medical law and Medical Ethics - Cambridge University Press-2014

COURSE OUTCOMES:

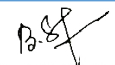
On completion of the course, the students will be able to

CO1:	Explain fundamental concepts of medical ethics, ethical theories, moral principles, and professional responsibilities in healthcare practice
CO2:	Analyze ethical issues in medical practice, biomedical research, human genetics, and confidentiality in healthcare settings
CO3:	Describe hospital accreditation and safety standards including JCI policies, life safety, and environment of care standards
CO4:	Interpret and apply medical equipment safety standards (IEC 60601, ISO, Indian & International standards) through case studies
CO5:	

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	3	-	2	2
CO3	-	-	-	2	2
CO4	-	3	2	3	3
CO5	-	3	2	3	3
Avg.	-	1.8	0.8	2	2

1 - Slight, 2 - Moderate, 3 -Substantial, BT - Bloom's Taxonomy


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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PAXC2401	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C	100
		2	0	0	0	
Course Objectives	• Teach how to improve writing skills and level of readability • Tell about what to write in each section • Summarize the skills needed when writing a Title • Infer the skills needed when writing the Conclusion • Ensure the quality of paper at very first-time submission					

Unit-I	INTRODUCTION TO RESEARCH PAPER WRITING	(9)
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness		
Unit-II	PRESENTATION SKILLS	(9)
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction		
Unit-III	TITLE WRITING SKILLS	(9)
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check		
Unit-IV	RESULT WRITING SKILLS	(9)
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions		
Unit-V	VERIFICATION SKILLS	(9)
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission		
Total No of Periods to be Taught		45 Periods

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understand that how to improve your writing skills and level of readability
CO2:	Learn about what to write in each section
CO3:	Understand the skills needed when writing a Title
CO4:	Understand the skills needed when writing the Conclusion
CO5:	Ensure the good quality of paper at very first-time submission

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Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	-	-	-	-
CO2	-	3	-	-	-	-
CO3	-	3	-	-	-	-
CO4	-	3	-	-	-	-
CO5	-	3	-	-	-	-
Avg.	-	3	-	-	-	-

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy

T. Subramani

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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PAXC2402	DISASTER MANAGEMENT	L	T	P	C	100
		2	0	0	0	
Course Objectives	- Summarize basics of disaster - Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response. - Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. - Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. - Develop the strengths and weaknesses of disaster management approaches					

Unit-I	INTRODUCTION	(6)
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.		
Unit-II	REPERCUSSIONS OF DISASTERS AND HAZARDS	(6)
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.		
Unit-III	DISASTER PRONE AREAS IN INDIA	(6)
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics		
Unit-IV	DISASTER PREPAREDNESS AND MANAGEMENT	(6)
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.		
Unit-V	RISK ASSESSMENT	(6)
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival		
Total No of Periods to be Taught		30 Periods

REFERENCES:

1	Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2	Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company, 2007.

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3	Sahni, PardeepEt.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall OfIndia, New Delhi,2001.
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COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Ability to summarize basics of disaster
CO2:	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3:	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4:	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

Mapping of COs with POs						
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	1	-	1
CO2	-	-	1	2	-	1
CO3	-	-	1	2	1	-
CO4	-	-	1	2	2	-
CO5	-	-	1	2	-	-
Avg.	-	-	1	2	1	1
1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy						


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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PAXC2403	CONSTITUTION OF INDIA	L	T	P	C	100
		2	0	0	0	
Course Objectives	- Understand the premises in forming the twin themes of liberty and freedom from a civil rights perspective. - To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional - Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism. - To address the role of socialism in India after the commencement of the Bolshevik Revolution in1917and its impact on the initial drafting of the Indian Constitution					

Unit-I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	(5)
History, Drafting Committee, (Composition & Working)		
Unit-II	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	(5)
Preamble, Salient Features		
Unit-III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	(5)
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-IV	ORGANS OF GOVERNANCE	(5)
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-V	LOCAL ADMINISTRATION	(5)
District's Administration head: Role and Importance, of Elected Representative, CEO, Municipal Corporation. Pachayatiraj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		
Unit-VI	ELECTION COMMISSION	(5)
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.		
Total No of Periods to be Taught		30 Periods

REFERENCES:	
1	The Constitution of India, 1950 (Bare Act), Government Publication
2	Dr.S.N.Busi, Dr.B.R. Ambedkar framing of Indian Constitution, 1 st Edition, 2015
3	M.P.Jain, Indian Constitution Law, 7 th Edn., Lexis Nexis, 2014.

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4D.D.Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics
CO2:	Discuss the intellectual origins of the frame work of argument that informed the conceptualization of social reforms leading to revolution in India
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4:	Discuss the passage of the Hindu Code Bill of 1956

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	1	-
CO2	1	-	-	-	2	-
CO3	-	-	-	2	-	2
CO4	-	-	3	1	-	-
CO5	-	2	-	-	2	-
Avg.	1	2	3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

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Department	Biomedical Engineering	Programme Code & Name	482- ME BME
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AUDIT COURSE

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PAXC2404	நற்றமிழ் இலக்கியம்	L	T	P	C	100
		2	0	0	0	

Unit-I	சங்க இலக்கியம்	(6)
சங்க இலக்கியம் 1.தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள் 2.அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம் 3.குறிஞ்சிப் பாட்டின் மலர்க்காட்சி 4.புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார்		
Unit-II	அறநெறித் தமிழ்	(6)
1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ் 2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)		
Unit-III	இரட்டைக் காப்பியங்கள்	(6)
1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை 2. சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை		

Unit-IV		(6)
அருள்நெறித் தமிழ் 1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள் 2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு 3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள் 4. தர்மச்சாலையை நிறுவிய வள்ளலார் 5. புறநானூறு - சிறுவனே வள்ளலானான் 6. அகநானூறு (4) - வண்டு நற்றிணை (11) - நண்டு கலித்தொகை (11) - யானை, புறா ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்		
Unit-V	நவீன தமிழ் இலக்கியம்	(6)
நவீன தமிழ் இலக்கியம் 6 1. உரைநடைத் தமிழ், - தமிழின் முதல் புதினம், - தமிழின் முதல் சிறுகதை, - கட்டுரை இலக்கியம், - பயண இலக்கியம், - நாடகம், 2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும், 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும், 4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும், 5. அறிவியல் தமிழ், 6. இணையத்தில் தமிழ், 7. கருத்துக்கூரல், பேர்ப்பாட்டில் தமிழ் இலக்கியம்.		
Weightage:		
Total No of Periods to be Taught		30

REFERENCES:

1

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
- www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
- <https://ta.wikipedia.org>
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்

- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
- தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்



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Department	EEE	Programme Code & Name	Except PSE
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Course Code	Course Name	Hours/Week			Credit	Maximum Marks
PEVO2414	RENEWABLE ENERGY TECHNOLOGY	L	T	P	C	100
		3	0	0	3	
Course Objectives	To impart knowledge on • Different types of renewable energy technologies • Standalone operation, grid connected operation of renewable energy systems					

Unit-I	INTRODUCTION	(9)
Classification of energy sources - Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - C02 Emission - importance of renewable energy sources, Potentials- Achievements- Applications		
Unit-II	SOLAR PHOTOVOLTAICS	(9)
Solar Energy: Basic Characteristics of solar radiation- angle of sunrays on solar Collector- Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell characteristics: P-V and I-V curve of cell-impact of Temperature and Insolation on I-V characteristics Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.		
Unit-III	PHOTOVOLTAIC SYSTEM DESIGN	(9)
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classificationstandalone PV systems - Grid tied and grid interactive inverters- grid connection issues.		
Unit-IV	WIND ENERGY CONVERSION SYSTEMS	(9)
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.		
Unit-V	OTHER RENEWABLE ENERGY SOURCES	(9)
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (QTEC), Tidal and wave energy, Geothermal Energy Resources.		
Total No of Periods to be Taught		45 periods

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TEXT BOOK:

1	Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2	Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005

REFERENCES:

1	Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
2	Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
3	Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Demonstrate the need for renewable energy sources.
CO2:	Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3:	Design a stand-alone and Grid connected PV system.
CO4:	Analyze the different configurations of the wind energy conversion systems..
CO5:	Realize the basic of various available renewable energy sources.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	-	3	1	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3	2	3
CO3	2	2	1	-	-	-	-	-	-	-	-	3	3	1
CO4	3	2	3	-	-	-	-	-	-	-	-	3	2	3
CO5	3	3	3	-	-	-	-	-	-	-	-	3	2	3
Avg.	3	2	3	-	-	-	-	-	-	-	-	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2401	IPR, BIOSAFETY AND ENTREPRENEURSHIP	L	T	P	C	100
		3	0	0	3	
Course Objectives	- To provide fundamental knowledge of Intellectual Property Rights (IPR), their types, significance, and role in innovation and technology development. - To impart knowledge of biosafety principles, regulations, risk assessment, and containment measures in biotechnology and related fields. - To develop an understanding of Genetically Modified Organisms (GMOs), their development, applications, benefits, risks, and regulatory aspects.					

Unit-I	IPR	(9)
Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.		
Unit-II	AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES	(9)
History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties –Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” –Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies.		
Unit-III	BIOSAFETY	(9)
Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.		
Unit-IV	GENETICALLY MODIFIED ORGANISMS	(9)
Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis –Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.		
Unit-V	ENTREPRENEURSHIP DEVELOPMENT	(9)
Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis –Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.– Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.		

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Total No of Periods to be Taught	45 Periods
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REFERENCES:	
1	Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2	Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3	Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4	Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5	Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.

COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	Explain the concepts, types, and significance of Intellectual Property Rights (IPR) and their role in protecting innovations.
CO2:	Describe the major international agreements, treaties, and patent filing procedures related to intellectual property protection.
CO3:	Apply biosafety principles and regulations to identify and manage risks associated with biological materials and biotechnology practices.
CO4:	Analyze the development, applications, benefits, and regulatory issues of Genetically Modified Organisms (GMOs).
CO5:	Demonstrate entrepreneurial skills by preparing business plans and evaluating opportunities for technology commercialization and venture creation.

Mapping of COs with POs						
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	-	-	-


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CO2	-	-	2	-	-	-
CO3	-	-	2	1	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	1	-	-
Avg.	-	1	3	-	-	-
1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy						


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Department	CIVIL	Programme Code & Name	Except EE, CEM
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Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2403	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C	100
		3	0	0	3	
Course Objectives	• To gain knowledge about Valuing the Environment. • To understand the Sustainable Development. • To understand the concepts of significance of biodiversity • To understand the concepts of pollution impacts • To understand the concepts of environmental economics					

Unit-I	INTRODUCTION	(9)
Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems		
Unit-II	CONCEPT OF SUSTAINABILITY	(9)
Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture		
Unit-III	SIGNIFICANCE OF BIODIVERSITY	(9)
Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation		
Unit-IV	POLLUTION IMPACTS	(9)
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.		
Unit-V	ENVIRONMENTAL ECONOMICS	(9)
Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics		
Total No of Periods to be Taught		45 periods

REFERENCES:	
1	Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2	Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3	Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4	Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5	Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019


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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Identify the need and importance of Environmental Sustainability
CO2:	Explain the various concept of sustainability
CO3:	Describe the importance of Biodiversity
CO4:	Describe the importance of pollution impacts
CO5:	Explain the dynamics of environmental economics.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	-	-	-	-	1	3	3
CO2	3	3	3	-	-	-	-	-	-	-	-	2	1	3
CO3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
CO4	3	2	3	-	-	-	-	-	-	-	-	2	2	3
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	3
Avg.	3	2	3	-	-	-	-	-	-	-	-	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

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Department	CSE	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2405	MACHINE LEARNING AND DEEP LEARNING	L	T	P	C	100
		3	0	0	3	
Course Objectives	• Understanding about the learning problem and algorithms • Providing insight about neural networks • Introducing the machine learning fundamentals and significance • Enabling the students to acquire knowledge about pattern recognition. • Motivating the students to apply deep learning algorithms for solving real life problems.					

Unit-I	LEARNING PROBLEMS AND ALGORITHMS	(9)
Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms		
Unit-II	NEURAL NETWORKS	(9)
Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.		
Unit-III	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	(9)
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.		
Unit-IV	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	(9)
Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.		
Unit-V	DEEP LEARNING: RNNs, AUTOENCODERS AND GANS	(9)
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs		
Total No of Periods to be Taught		45 Periods

REFERENCES:	
1	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2	Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.

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3	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

COURSE OUTCOMES:

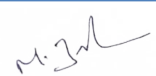
On completion of the course, the students will be able to

CO1:	Illustrate the categorization of machine learning algorithms.
CO2:	Compare and contrast the types of neural network architectures, activation functions
CO3:	Acquaint with the pattern association using neural networks
CO4:	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5:	Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy


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Department	CSE	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2406	IoT FOR SMART SYSTEMS	L	T	P	C	100
		3	0	0	3	
Course Objectives	- To study about Internet of Things technologies and its role in real time applications. - To introduce the infrastructure required for IoT - To familiarize the accessories and communication techniques for IoT. - To provide insight about the embedded processor and sensors required for IoT - To familiarize the different platforms and Attributes for IoT					

Unit-I	INTRODUCTION TO INTERNET OF THINGS	(9)
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.		
Unit-II	IOT ARCHITECTURE	(9)
IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.		
Unit-III	PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT	(9)
PROTOCOLS: NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.		
Unit-IV	IOT PROCESSORS	(9)
Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.		
Unit-V	CASE STUDIES	(9)
Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense		
Total No of Periods to be Taught		45 Periods

REFERENCES:	
1	ArshdeepBahga and VijaiMadiseti : A Hands-on Approach “Internet of Things”, Universities Press 2015.
2	Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley, 2016.


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3	Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4	Adrian McEwen and Hakim Cassimally “Designing the Internet of Things “Wiley, 2014.
5	Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Analyze the concepts of IoT and its present developments.
CO2:	Compare and contrast different platforms and infrastructures available for IoT
CO3:	Explain different protocols and communication technologies used in IoT
CO4:	Analyze the big data analytic and programming of IoT
CO5:	Implement IoT solutions for smart applications

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	-	-	-
CO2	-	-	2	-	-	-
CO3	-	-	2	1	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	1	-	-
Avg.	-	1	3	-	-	-

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy


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Department	CSE	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2409	PRINCIPLES OF MULTIMEDIA	L	T	P	C	100
		3	0	0	3	
Course Objectives	• To get familiarity with gamut of multimedia and its significance • To acquire knowledge in multimedia components. • To acquire knowledge about multimedia tools and authoring. • To acquire knowledge in the development of multimedia applications. • To explore the latest trends and technologies in multimedia					

Unit-I	INTRODUCTION	(9)
Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components– Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.		
Unit-II	ELEMENTS OF MULTIMEDIA	(9)
Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations –data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.		
Unit-III	MULTIMEDIA TOOLS	(9)
Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools..		
Unit-IV	MULTIMEDIA SYSTEMS	(9)
Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.		
Unit-V	MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS	(9)
ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.		
Total No of Periods to be Taught		45 Periods


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REFERENCES:

1	Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021.
2	Prabhat K. Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015.
3	Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4	Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017

COURSE OUTCOMES:

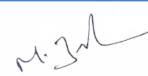
On completion of the course, the students will be able to

CO1:	Handle the multimedia elements effectively.
CO2:	Articulate the concepts and techniques used in multimedia applications.
CO3:	Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4:	Design and implement algorithms and techniques applied to multimedia objects.
CO5:	Design and develop multimedia applications following software engineering models.

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy


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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2413	SUSTAINABLE MANAGEMENT	L	T	P	C	100
		3	0	0	3	
Course Objectives	- To provide students with fundamental knowledge of the notion of corporate sustainability. - To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.					

Unit-I	MANAGEMENT OF SUSTAINABILITY	(9)
Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.		
Unit-II	CORPORATE SUSTAINABILITY AND RESPONSIBILITY	(9)
Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.		
Unit-III	SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES	(9)
Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.		
Unit-IV	SUSTAINABILITY AND INNOVATION	(9)
Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.		
Unit-V	SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS	(9)
Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.		
Total No of Periods to be Taught		45 Periods

REFERENCES:	
1	Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2	Christian N. Madu, Handbook of Sustainability Management 2012
3	Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4	Margaret Robertson, Sustainability Principles and Practice, 2014


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5	Peter Rogers, An Introduction to Sustainable Development, 2006
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COURSE OUTCOMES:	
On completion of the course, the students will be able to	
CO1:	An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2:	An understanding of corporate sustainability and responsible Business Practices
CO3:	Knowledge and skills to understand, to measure and interpret sustainability performances. landscape system.
CO4:	Knowledge of innovative practices in sustainable business and community management
CO5:	Deep understanding of sustainable management of resources and commodities

Mapping of COs with POs						
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	-	-	-
CO2	-	-	2	-	-	-
CO3	-	-	2	1	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	1	-	-
Avg.	-	1	3	-	-	-
1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy						

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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2414	MICRO AND SMALL BUSINESS MANAGEMENT	L	T	P	C	100
		3	0	0	3	
Course Objectives	- To familiarize students with the theory and practice of small business management. - To learn the legal issues faced by small business and how they impact operations.					

Unit-I	INTRODUCTION TO SMALL BUSINESS	(9)
Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.		
Unit-II	SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN	(9)
Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.		
Unit-III	BUILDING THE RIGHT TEAM AND MARKETING STRATEGY	(9)
Management and Leadership – employee assessments – Tuckman's stages of group development The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model. Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.		
Unit-IV	FINANCING SMALL BUSINESS	(9)
Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.		
Unit-V	VALUING SMALL BUSINESS AND CRISIS MANAGEMENT	(9)
Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.		
Total No of Periods to be Taught		45 Periods

REFERENCES:

1	Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
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2	Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3	Journal articles on SME's.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Familiarise the students with the concept of small business
CO2:	In depth knowledge on small business opportunities and challenges
CO3:	Ability to devise plans for small business by building the right skills and marketing strategies
CO4:	Identify the funding source for small start ups
CO5:	Business evaluation for buying and selling of small firms

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy

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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2415	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C	100
		3	0	0	3	
Course Objectives	To understand intellectual property rights and its valuation.					

Unit-I	INTRODUCTION	(9)
Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.		
Unit-II	PROCESS	(9)
New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.		
Unit-III	STATUTES	(9)
International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh-Dole Act and Issues of Academic Entrepreneurship.		
Unit-IV	STRATEGIES IN INTELLECTUAL PROPERTY	(9)
Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.		
Unit-V	MODELS	(9)
The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.		
Total No of Periods to be Taught		45 Periods

REFERENCES:

1	V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2	Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
3	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
4	WIPO Intellectual Property Hand book.

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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understanding of intellectual property and appreciation of the need to protect it
CO2:	Awareness about the process of patenting
CO3:	Understanding of the statutes related to IPR
CO4:	Ability to apply strategies to protect intellectual property
CO5:	Ability to apply models for making strategic decisions related to IPR

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	1	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy

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Department	MBA	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2416	ETHICAL MANAGEMENT	L	T	P	C	100
		3	0	0	3	
Course Objectives	To help students develop knowledge and competence in ethical management and decision making in organizational contexts.					

Unit-I	ETHICS AND SOCIETY	(9)
Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community		
Unit-II	ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS	(9)
Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.		
Unit-III	STAKEHOLDERS IN ETHICAL MANAGEMENT	(9)
Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).		
Unit-IV	INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT	(9)
Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision- making and management.		
Unit-V	PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS	(9)
Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.		
Total No of Periods to be Taught		45 Periods

REFERENCES:	
1	Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2	Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3	Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Role modelling and influencing the ethical and cultural context.
CO2:	Respond to ethical crises and proactively address potential crises situations.
CO3:	Understand and implement stakeholder management decisions.
CO4:	Develop the ability, knowledge, and skills for ethical management.
CO5:	Develop practical skills to navigate, resolve and thrive in management situations

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy

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Department	CSE	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2420	BLOCK CHAIN TECHNOLOGIES	L	T	P	C	100
		3	0	0	3	
Course Objectives	• This course is intended to study the basics of Block chain technology. • During this course the learner will explore various aspects of Block chain technology like application in various domains. • By implementing, learners will have idea about private and public Block chain, and smart contract.					

Unit-I	INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN	(9)
Introduction to Block chain, Block chain Technology Mechanisms & Networks, Block chain Origins, Objective of Block chain, Block chain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Block chain.		
Unit-II	BITCOIN AND CRYPTOCURRENCY	(9)
Introduction to Bit coin, The Bit coin Network, The Bit coin Mining Process, Mining Developments, Bit coin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Block chain and Digital Currency, Transactional Blocks, Impact of Block chain Technology on Crypto currency.		
Unit-III	INTRODUCTION TO ETHEREUM	(9)
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.		
Unit-IV	INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING	(9)
Introduction to Hyper ledger, Distributed Ledger Technology & its Challenges, Hyper ledger & Distributed Ledger Technology, Hyper ledger Fabric, Hyper ledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.		
Unit-V	BLOCKCHAIN APPLICATIONS	(9)
Internet of Things, Medical Record Management System, Domain Name Service and Future of Block chain, Alt Coins. Coding of Speech Signals, Quadrature Mirror Filters, Over Sampling A/D and D/A Conversion.		
Total No of Periods to be Taught		45 Periods

REFERENCES:	
1	Imran Bashir, "Mastering Block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2	Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Crypto currency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3	Antonopoulos, Mastering Bit coin, O'Reilly Publishing, 2014.

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4	Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5	D. Drescher, Block chain Basics. Apress, 2017.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understand and explore the working of Block chain technology
CO2:	Analyze the working of Smart Contracts
CO3:	Understand and analyze the working of Hyper ledger
CO4:	Apply the learning of solidity to build de-centralized apps on Ethereum
CO5:	Develop applications on Block chain

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy


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Department	EEE	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2423	ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS	L	T	P	C	100
		3	0	0	3	
Course Objectives	• To learn the present energy scenario and the need for energy conservation. • To understand the different measures for energy conservation in utilities. • Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings. • To identify the energy demand and bridge the gap with suitable technology for sustainable habitat • To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement					

Unit-I	ENERGY SCENARIO	(9)
Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.		
Unit-II	HEATING, VENTILLATION & AIR CONDITIONING	(9)
Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.		
Unit-III	LIGHTING, COMPUTER, TV	(9)
Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.		
Unit-IV	ENERGY EFFICIENT BUILDINGS	(9)
Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.		
Unit-V	ENERGY STORAGE TECHNOLOGIES	(9)
Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.		
Total No of Periods to be Taught		45 Periods

REFERENCES:

1	Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2	ASHRAE Handbook 2020 – HVAC Systems & Equipment
3	Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001

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4	David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
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COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Understand technical aspects of energy conservation scenario.
CO2:	Energy audit in any type for domestic buildings and suggest the conservation measures.
CO3:	Perform building load estimates and design the energy efficient landscape system.
CO4:	Gain knowledge to utilize an appliance/device sustainably.
CO5:	Understand the status and current technological advancement in energy storage field.

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	-	-	-
CO2	-	-	2	-	-	-
CO3	-	-	2	1	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	1	-	-
Avg.	-	1	3	-	-	-

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom's Taxonomy

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Department	MECHANICAL	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2424	ADDITIVE MANUFACTURING	L	T	P	C	100
		3	0	0	3	
Course Objectives	• This course is intended to study the basics of Additive Manufacturing. • During this course the learner will explore various design aspects of Additive Manufacturing. • By implementing, learners will deal with real time Case studies					

Unit-I	INTRODUCTION	(9)
Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.		
Unit-II	DESIGN FOR ADDITIVE MANUFACTURING	(9)
CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.		
Unit-III	VAT POLYMERIZATION	(9)
Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.		
Unit-IV	MATERIAL EXTRUSION AND SHEET LAMINATION	(9)
Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle– Materials- Application and Limitation - Three Dimensional Printing - Materials - Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.		
Unit-V	CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES	(9)
Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.		
Total No of Periods to be Taught		45 Periods

REFERENCES:

1	Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
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2	Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3	Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5	Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the fundamentals of various Additive Manufacturing (AM) techniques.
CO2:	Develop mathematical models to represent curves, surfaces and solids
CO3:	Identify STL file problems and apply repair algorithms
CO4:	Determine part orientation for minimum build time and part errors
CO5:	Explore the range of 3D printing and Prototyping technologies and their application for industrial, design, and creative field.

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	1	2	-	3
CO2	1	-	2	1	-	2
CO3	2	-	1	2	1	3
CO4	-	-	1	2	1	2
CO5	1	-	1	2	3	3
Avg.	1	-	1	2	1	3

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy

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Department	MECH	Programme Code & Name	Common to all PG Branches
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Semester 3

Course Code	Course Name	Hours/Week			Credit	Maximum Marks
POE2425	ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C	100
		3	0	0	3	
Course Objectives	• To understand the architecture, configuration, and major components of electric vehicles and their operating principles. • To study various energy sources used in electric vehicles, including batteries, fuel cells, and super capacitors, along with their characteristics. • To learn the fundamentals of electric drives, traction motors, power electronic converters, and control techniques employed in electric vehicles. • To gain knowledge of electric vehicle charging systems, charging standards, charging infrastructure, and energy management methods.					

Unit-I	NEED FOR ELECTRIC VEHICLES	(9)
History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges		
Unit-II	ELECTRIC VEHICLE ARCHITECTURE	(9)
Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.		
Unit-III	ENERGY STORAGE	(9)
Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell		
Unit-IV	ELECTRIC DRIVES AND CONTROL	(9)
Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control, AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers		
Unit-V	DESIGN OF ELECTRIC VEHICLES	(9)
Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.		
Total No of Periods to be Taught		45 Periods


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REFERENCES:

1	IqbalHussein,ElectricandHybridVehicles:DesignFundamentals,2 nd editionCRCPress,2011.
2	MehrdadEhsani,YimiGao,SebastianE.Gay,AliEmadi,ModernElectric,HybridElectricandFuelCell Vehicles:Fundamentals,Theoryand Design,CRCPress,2004.
3	JamesLarminie,JohnLowry, ElectricVehicleTechnologyExplained- Wiley,2003.
4	Ehsani,M,“ModernElectric,HybridElectricandFuelCellVehicles:Fundamentals,TheoryandDesign”,CRC Press,2005

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Explain the architecture, components, and operating principles of electric vehicles, including powertrain configurations and vehicle subsystems.
CO2:	Analyze various energy sources used in electric vehicles, including batteries, fuel cells, and supercapacitors, along with their characteristics and performance parameters.
CO3:	Describe the operation of electric drive systems, motor control techniques, and power electronic converters used in electric vehicles.
CO4:	Evaluate electric vehicle charging methods, charging standards, charging infrastructure, and energy management strategies.
CO5:	Apply vehicle design principles to estimate performance parameters and develop suitable electric vehicle configurations for specific applications.

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	3	-	-	-
CO2	-	-	2	-	-	-
CO3	-	-	2	1	-	-
CO4	-	-	3	-	-	-
CO5	-	-	2	1	-	-
Avg.	-	1	3	-	-	-

1 – Slight, 2 – Moderate, 3 –Substantial , BT – Bloom’s Taxonomy

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