SEMESTER VII

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	BM19701	Medical Image Processing	3	0	0	3
2	PC	BM19702	Healthcare and Hospital Management	3	0	0	3
3	PE	BM1935*	Professional Elective III	3	0	0	3
4	PE	BM1945*	Professional Elective IV	3	0	0	3
5	OE	BM1990*	Open Elective II	3	0	0	3
Practical							
6	PC	BM19703	Medical Image Processing Laboratory	0	0	4	2
7	EE	BM19704	Hospital Internship Training	0	0	2	1
8	EE	BM19705	Project Work (Phase I)	0	0	6	3
			Total	**15**	**0**	**12**	**21**

SEMESTER VIII

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	BM19801	Radiological Equipment	3	0	0	3
2	PE	BM1955*	Professional Elective V	3	0	0	3
3	PE	BM1965*	Professional Elective VI	3	0	0	3
Practical							
4	EE	BM19802	Project Work (Phase II)	0	0	12	6
			Total	**9**	**0**	**12**	**15**
							Total Credits : 161

PROFESSIONAL ELECTIVE I

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19151	Biomedical Informatics	3	0	0	3
2	PE	BM19152	Virtual Bioinstrumentation	3	0	0	3
3	PE	BM19153	BioMEMS	3	0	0	3
4	PE	BM19154	Medical Optics	3	0	0	3

PROFESSIONAL ELECTIVE II

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19251	Telemedicine and PACS	3	0	0	3
2	PE	BM19252	Advanced Medical Instrumentation Technology	3	0	0	3
3	PE	BM19253	Pattern Recognition and Neural Networks	3	0	0	3
4	PE	BM19254	Advanced Medical Signal Processing	3	0	0	3

PROFESSIONAL ELECTIVE III

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19351	Fundamentals of Biomedical Nanotechnology	3	0	0	3
2	PE	BM19352	Tissue Engineering	3	0	0	3
3	PE	BM19353	Telehealth Technology	3	0	0	3
4	PE	BM19354	Design and Development of Medical Devices	3	0	0	3

PROFESSIONAL ELECTIVE IV

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19451	Medical Optics and Laser Applications	3	0	0	3
2	PE	BM19452	Medical Ethics Standards and Safety	3	0	0	3
3	PE	BM19453	Advanced Healthcare System Design	3	0	0	3
4	PE	BM19454	Artificial Intelligence for Healthcare	3	0	0	3

PROFESSIONAL ELECTIVE V

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19551	Artificial Organs and Implants	3	0	0	3
2	PE	BM19552	Embedded Systems and Internet of Things in Healthcare	3	0	0	3
3	PE	BM19553	Physiological Modelling	3	0	0	3
4	PE	BM19554	Robotics and Automation in Medicine	3	0	0	3

PROFESSIONAL ELECTIVE VI

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	BM19651	Virtual Reality in Medicine	3	0	0	3
2	PE	BM19652	Wearable Devices and its Application	3	0	0	3
3	PE	BM19653	Quality Control in Biomedical Engineering	3	0	0	3
4	PE	BM19654	Medical Radiation Safety	3	0	0	3

OPEN ELECTIVE I

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	BM19901	Industrial Nanotechnology	3	0	0	3
2	OE	BM19902	Biomedical Waste Management	3	0	0	3

OPEN ELECTIVE II

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	BM19903	Basics of Telemedicine	3	0	0	3
2	OE	BM19904	Patient and Device Safety	3	0	0	3

ONE CREDIT COURSE

S. No	Category	Course Code	Course Title	L	T	P	C
1	OCC	BM19951	Embedded Programming using ARDUINO	0	0	2	1
2	OCC	BM19952	PC Hardware Assembling and Troubleshooting	0	0	2	1
3	OCC	BM19953	Basic Electronic Circuit Design using Multisim	0	0	2	1
4	OCC	BM19954	MATLAB Programming	0	0	2	1
5	OCC	BM19955	Labview Programming	0	0	2	1
6	OCC	BM19956	Open source programming using Linux	0	0	2	1
7	OCC	BM19957	PCB Design using KICAD EDA Tool	0	0	2	1
8	OCC	BM19958	VHDL Programming	0	0	2	1
9	OCC	BM19959	NPTEL – Swayam – 4 Weeks Course	0	0	2	1

BM20701 **RADIOLOGICAL EQUIPMENT** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand generation of x-rays and its applications in imaging.
- learn different types of radio diagnostic techniques.
- know sending and receiving of signals in radio frequency coils.
- know techniques used for visualizing different sections of the body
- learn radiation therapy methodologies and the radiation safety.

UNIT I MEDICAL X-RAY EQUIPMENT **9**

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

UNIT II COMPUTED TOMOGRAPHY **9**

Principles of tomography; CT Generations - X- Ray sources, collimation, X- Ray detectors, Viewing systems, spiral CT scanning, ultrafast CT scanners; Image reconstruction techniques back projection and iterative method.

UNIT III MAGNETIC RESONANCE IMAGING **9**

Fundamentals of magnetic resonance - Interaction of Nuclei with static magnetic field and Radiofrequency wave, rotation and precession; Induction of magnetic resonance signals - bulk Magnetization, Relaxation processes T1 and T2; Block Diagram approach of MRI system - system Magnet (Permanent, Electromagnet and Super conductors), Gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils; Electronic components - FMRI.

UNIT IV NUCLEAR IMAGING SYSTEM **9**

Radio Isotopes - alpha, beta, and gamma radiations; Radiopharmaceuticals; Radiation detectors - gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors; Gamma camera - Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height Analyzer; Principles of SPECT and PET.

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

Effects of radiation - direct and indirect; Radiation therapy - linear accelerator, Tele gamma Machine; Recent Techniques in radiation therapy - Stereotaxic Radiosurgery, Stereotaxic Radiotherapy, 3D CRT, IMRT, IGRT and Cyber knife; Radiation measuring instruments - Dosimeter, film Badges, Thermo Luminescent dosimeters - electronic dosimeter; Radiation protection in medicine - radiation protection principles, ICRP, AERB.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- paraphrase the principle and working of various radiography equipment.
- design the tomography concept and image reconstruction techniques.
- illustrate the basic principle and working of Magnetic resonance imaging technique.
- analyze the concept of nuclear imaging techniques and radiation detectors.
- demonstrate the effects of radiation, radiation safety and the principle of Radio therapy.

TEXT BOOKS

1. Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone, 'The Essential
2. Physics of Medical Imaging'', Lippincott Williams and Wilkins, 3rd Edition, 2012.

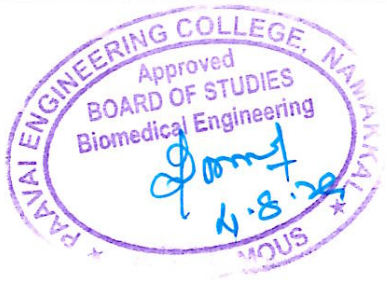
REFERENCES

1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine'', Springer, 3rd Edition 2006.
2. B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, "Medical physics andBiomedical Engineering'', - CRC Press,1999.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine concepts andTechniques'', Orient Longman,2007.

CO/PO MAPPING :

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3	3		3		2			3	3	
CO2	2		3	3	3		3		2			2	3	
CO3	3		3	2	3		2					2	3	
CO4	2		3	3	3		2		2			3	3	
CO5	3		3	3	2		2					3	3	



BM20702 **MEDICAL IMAGE PROCESSING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the basic concept of image fundamentals.
- identify the designing concept of post processing
- familiarize medical image representation.
- acquire knowledge on medical image analysis.
- infer knowledge on image compression, recognition.

UNIT I DIGITAL IMAGE FUNDAMENTALS **9**

Steps in Digital Image Processing - Components; Elements of Visual Perception; Image Sensing and Acquisition; Image Sampling and Quantization; Relationships between pixels; Color image fundamentals - RGB, HSI model; Two-dimensional mathematical preliminaries; 2D transforms - DFT, DCT.

UNIT II IMAGE ENHANCEMENT **9**

Spatial Domain - Gray level transformations, Histogram processing; Basics of Spatial Filtering - Smoothing and Sharpening Spatial Filtering; Frequency Domain - Introduction to Fourier Transform, Smoothing and Sharpening frequency domain filters, Ideal, Butterworth and Gaussian filters, Homomorphic filtering; Color image enhancement.

UNIT III IMAGE RESTORATION, THRESHOLDING AND SEGMENTATION **9**

Image Restoration - degradation model, Properties; Noise models - Mean Filters, Order Statistics; Adaptive filters - Band reject Filters, Band pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering. Thresholding and Segmentation - Detection methods, optimal thresholding, multi-spectral thresholding; Edge based segmentation, Edge detection, Edge linking via Hough transform; Region based segmentation - Matching, Region growing, Region splitting and merging.

UNIT IV IMAGE COMPRESSION AND RECOGNITION **9**

Morphological processing - erosion and dilation; Segmentation by morphological watersheds - basic concepts, Dam construction, Watershed segmentation algorithm; Need for data compression; Huffman, Run Length Encoding; Shift codes - Arithmetic coding, JPEG standard, MPEG; Boundary representation - Boundary description, Fourier Descriptor, Regional Descriptors; Topological feature - Texture, Patterns and Pattern classes, Recognition based on matching.

UNIT V BIOMEDICAL IMAGES

Biomedical Images - Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis; Applications - Contrast enhancement of mammograms, Detection of calcifications by region growing, Shape and texture analysis of tumors.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- analyze the basics of image processing.
- summarize the major processes involved in formation of images.
- recognize the imaging modality from their visualization.
- illustrate the fundamental concepts of texture analysis.
- design and implement image processing applications that incorporates different concepts of medical image processing.

TEXT BOOKS

1. Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts and Applications", Prentice Hall, 2014.
2. Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007.

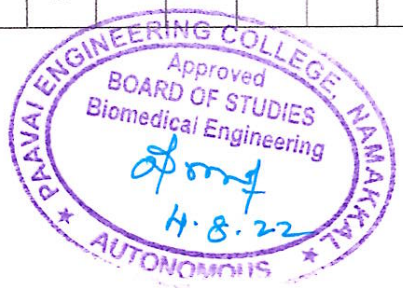
REFERENCES

1. Atam P. Dhawan, Medical Image Analysis John-Wiley & Sons Inc, New York published in the year 2003.
2. Medical Image Processing by G. Doughtery, Springer Link.
3. J. Michael Fitzpatrick and Milan Sonka, "Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis", SPIE Publications, 2009.
4. Paul Suetens, "Fundamentals of Medical Imaging", Second Edition, Cambridge University Press, 2009.

CO/PO MAPPING :

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									2					3
CO2	2			2					2					2
CO3	2			2	3					3		2	2	
CO4	2			2	3							3	3	
CO5	2			2						2		2		2



BM20703 **HOSPITAL INTERNSHIP TRAINING** **0 0 2 1**

COURSE OBJECTIVES

To enable students to

- improve the skills by visiting the hospitals.
- understand the working principle of various biomedical equipments.
- able to work on the equipments through internship.
- able to design the equipment prototype model.

GUIDELINE FOR HOSPITAL INTERNSHIP AND TRAINING

The students may be grouped into 2 to 4 members by internship coordinator. The students will be allowed for hospital internship training for 2 weeks during the holidays of VI semester. After the completion of Internship training, they will have to submit the report to the Coordinator and Head of the Department. At the end of the semester examination the Hospital Training report is evaluated based on oral presentation and is examined jointly by the committee constituted by the Head of the Department.

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- advocate a patient-centered approach in healthcare.
- communicate with other health professionals under various departments in a respectful and responsible manner.
- propose a patient-centered inter-professional health improvement record plan based upon the patient's perceived needs.
- use the knowledge of one's own role in a hospital and those of other professions to address the healthcare needs of populations and patients served.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3					3	3			2	3	3
CO2	3	3	3	3	3	2	2		2			3	3	2
CO3	3		3	3	3	3	2		2	2		3	2	3
CO4	3	3	3				2	3	3	3	2	3	2	2

PANIMALAR ENGINEERING COLLEGE, NAMAKKAL
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Biomedical Engineering
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BM20704 **MEDICAL IMAGE PROCESSING LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable students to

- analyze the basic image processing techniques.
- compute magnitude and phase representation of images.
- understand the concepts of image restoration and segmentation.
- study the various characteristics of analysis of bio-signals.

LIST OF EXPERIMENTS

1. Colour image processing.
2. Histogram Equalization.
3. Spatial filtering and non-linear filtering.
4. Edge detection using operators.
5. 2D DFT and DCT.
6. Filtering in frequency domain.
7. DWT of images.
8. Feature extraction of medical images.
9. Medical Image Compression techniques.
10. Medical Image fusion.
11. Wavelet decomposition and reconstruction.

TOTAL PERIODS: 60

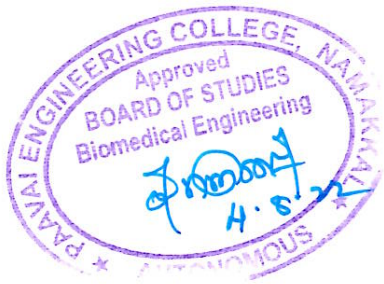
COURSE OUTCOMES

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

- use transforms and analyze the characteristics of the image.
- perform enhancing operations and segmentation operations on the image using spatial filters and frequency domain filters.
- estimate the efficiency of the compression technique on the images develop image processing algorithms for different image processing.
- apply image processing technique to solve real health care problems.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		**Programmes Outcomes(POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	3	3	3		3	3				3	3	3	3
CO2	1	3	3	3		3	3				3	3	3	3
CO3	1	3	3	3									3	3
CO4	1	3	3	3							3	3	3	3



BM20705 **PROJECT WORK (PHASE I)** **0 0 6 3**

COURSE OBJECTIVES

To enable students to

- improve the skills to formulate a technical project.
- explain the various tasks of the project and standard procedures.
- teach the use of new tools, algorithms and techniques required to carry out the projects.
- analyze the various procedures for validation of the product and analyze the cost effectiveness.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped upto 4 members and work under a project supervisor. The prototype/simulation may be decided in consultation with the supervisor. A Project Phase - I Report to be submitted by the group and the prototype model, which will be reviewed and evaluated for internal assessment by a Committee Constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the Project Phase - I report is examined jointly by external and internal examiners constituted by the Controller of Examinations. It is highly desirable to publish their Project idea in State/ National level Conferences or Symposiums.

TOTAL PERIODS 90

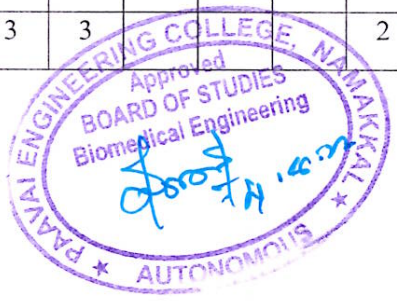
COURSE OUTCOMES

At the end of this project, the students will be able to

- formulate the real-world problem, identify the requirement and develop the design solutions.
- identify the technical ideas, strategies and methodologies.
- use the new tools, algorithms, techniques that contribute to obtain the solution of the project.
- analyze and validate through conformance of the developed prototype and analysis the cost effectiveness.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3					3	3			2	3	3
CO2	3	3	3	3	3	2	2		2			3	3	2
CO3	3		3	3	3	3	2		2	2		3	2	3
CO4	3	3	3				2	3	3	3	2	3	2	2



BM20801 **PROJECT WORK (PHASE II)** **0 0 12 6**

COURSE OBJECTIVES

To enable students to

- improve the skills to formulate a technical project.
- explain the various tasks of the project and standard procedures.
- teach the use of new tools, algorithms and techniques required to carry out the projects.
- analyze the various procedures for validation of the product and analyze the cost effectiveness.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped upto 4 members and work under a project supervisor. The process of fabrication has to be completed and submitted to the supervisor. The device/system/component to be prototype based; may be decided in consultation with the supervisor. A Project Phase - II Report to be submitted by the group and the prototype model, which will be reviewed and evaluated for internal assessment by a Committee Constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the Project Phase - II Report is examined jointly by external and internal examiners constituted by the Controller of Examinations. It is highly desirable to publish their Project in State/ National level conferences or Symposiums.

TOTAL PERIODS: 180

COURSE OUTCOMES

At the end of this project, the students will be able to

- formulate the real-world problem, identify the requirement and develop the design solutions.
- identify the technical ideas, strategies and methodologies.
- use the new tools, algorithms, techniques that contribute to obtain the solution of the project.
- analyze and validate through conformance of the developed prototype and analysis the cost. effectiveness

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3					3	3			2	3	3
CO2	3	3	3	3	3	2	2		2			3	3	2
CO3	3		3	3	3	3	2		2	2		3	2	3
CO4	3	3	3				2	3	3	3	2	3	2	2
CO5	3		3						2	3	3	2	2	2

BM20351 FUNDAMENTALS OF BIOMEDICAL NANOTECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable students to

- explain the basic principles of nanotechnology.
- learn the aspects based on bimolecular synthesis of nano materials.
- learn about the advantages of nano materials in medicine.
- familiarize about biosensors and its application in nanotechnology.
- acquire knowledge on applications of future technological advancements and increasing role of nanotechnology in biomedical industries.

UNIT I INTRODUCTION TO NANOTECHNOLOGY 9

Nano scale phenomena; Opportunities, Natural nanocomposite system; Types of nano structured materials - Zero dimensional, one dimensional, two dimensional and cluster of nanomaterial; Biomaterials - 1st, 2nd and 3rd generations of biomaterials; Nanoscale effects in properties - physical, mechanical, thermal, electrical and biological properties towards nano size.

UNIT II SYNTHESIS OF NANOPARTICLES 9

Top down and bottom up nanoparticles synthesis; physical methods - ball milling, PVD/Sputtering, CVD, Spray pyrolysis; Chemical methods - Sol gel, Hydrothermal, Electromechanical, Sonochemical; Lithography - Electron beam and Dip pin; Biological methods - green synthesis and microbial synthesis (Bacteria, Yeast, Fungi).

UNIT III FABRICATION AND CHARACTERISATION TECHNIQUES 9

Nanoforms of carbon materials - Buckyballs, fullerene, grapheme, carbon nanotubes (SWCNT and MWCNT); Characterization techniques of nanomaterials - UV visible, X-ray diffraction (XRD), FTIR; Scanning and Transmission Electron Microscopy (SEM and TEM) - Energy Dispersive X-Ray (EDX), Atomic Force Microscopy(AFM) and Nanoindentation.

UNIT IV NANOMATERIAL IN BIOSENSORS 9

Principles and applications nanomaterials - DNA and protein based nano biosensors; Future direction in biosensor research; MEMS and NEMS; Quantum dots - Synthesis, Properties, applications and drawbacks; Biochips and In-vivo imaging - Integrated nano sensor networks.

UNIT V NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY 9

Biodegradable Nanomaterials in bone substitutes - Implants and Prosthesis; MCNT and other Nanomaterials in cancer diagnosis and therapy drug delivery; Antibacterial agents; Tissue Engineering - Nano artificial cells; Nanorobotics - Photodynamic therapy; Potential risks (toxicity) and remedies towards environmental impact and human health.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- relate any architecture and assembly language for a processor.
- interpret the architectural and pipelining concepts for microprocessors.
- design and deploy the interfacing peripherals in real time scenario.
- design, develop and trouble shoot microcontroller-based system.
- implement microcontroller-based systems in biomedical domain.

TEXT BOOKS

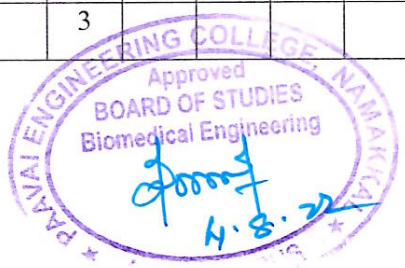
1. Neelina H. Malsch, "Biomedical Nanotechnology", Taylor & Francis Group, 19 Sep 2019.
2. Mauro Ferrari, Sangeeta N. Bhatia, Tejal Desai, "BioMEMS and Biomedical NanotechnologyVolume III: Therapeutic Micro/Nanotechnology · Volume 3", Springer US,1st illustrated reprint edition , 23 November 2010 .

REFERENCES

1. Emily S. Day, Sarah Hurst Petrosko, "Biomedical NanotechnologyMethods and Protocols", Springer New York, 9 June 2018 .
2. Chris Binns, "Introduction to Nanoscience and Nanotechnology", Wiley,16 June 2010.
3. S. Shanmugam, "Nanotechnology" MJP Publishers, 2011, ISBN 978-81-8094-0644.
4. Vikas Dhikav, "Fundamentals of Biomedical Research",CBS Publication, 1st Edition, 2018.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3		3	2						2		3
CO2	2		3		2									2
CO3	2		2		3	3							2	
CO4	2		3		3	3						3	3	
CO5	2		3		3									2



BM20352 **TISSUE ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- study cell cycle and differentiation
- learn basics about stem cells and its applications
- describe different synthetic and natural biomaterials in tissue replacements
- know the cell growth and differentiation, cell and tissue mechanism.
- study the cell adhesion, cell migration, cell aggregation and tissue equivalent.

UNIT I FUNDAMENTALS OF TISSUE ENGINEERING **9**

Tissue Engineering - Introduction, Objectives of tissue engineering; Laboratory set up for tissue engineering; Tissue development and Tissue exchange - Cell cycle and differentiation, cell adhesion, cell adhesion molecules, cell migration, cell aggregation and tissue equivalent.

UNIT II COMPONENTS OF TISSUE ENGINEERING **9**

Cell - Cell harvesting In Vitro Medium, Synthetic and Biological media; Scaffold - Natural and Synthetic scaffold; Cell and Drug delivery systems - Transplantation, Implantation; Nanotechnology in tissue engineering - Biocompatibility studies In Vitro and In Vivo.

UNIT III STEM CELLS AND GENE THERAPY **9**

Embryonic stem cells, Liver stem cells, adult epithelial tissue stem cells, mesenchymal stem cells; strategies of gene therapy - Ex vivo Vs in vivo gene therapy, gene transfer vector; cell - specific targeting strategies, combining gene transfer with stem cell strategies, challenges to gene therapy for tissue engineering.

UNIT IV MATERIALS IN TISSUE ENGINEERING **9**

Biological materials - degradable and non-degradable; extra cellular matrix - decellularization; Polymers - synthetic and natural, cell interaction with polymers, applications of polymer; Ceramics and Metals.

UNIT V APPLICATION OF TISSUE ENGINEERING **9**

Replacement Engineering - Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver; Regenerative engineering - peripheral Nerve regeneration, cardiac tissue regeneration, muscle regeneration; Tissue Engineered Food Regulation, Commercialization and Patenting.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- summarize the basic concept of tissue engineering
- illustrate the concept of stem cell and gene therapy
- apply the knowledge of professional and ethical responsibility in use of stem cells and gene therapy in creating tissue engineered therapies
- design and develop different biomaterial in tissue engineering application
- compose a research or clinical application on tissue repair/ engineering.

TEXT BOOKS

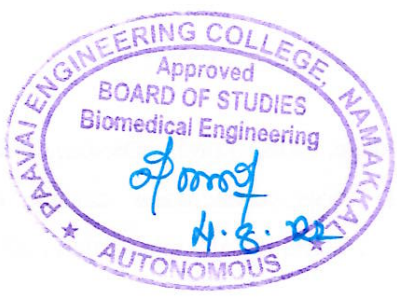
1. Robert P lanza, Robert Langer and Joseph Vacanti, "Principles of tissue engineering", Academic Press, California, 2007.
2. Larry L. Hench, Julian R. Jones, "Biomaterials, Artificial Organs and Tissue Engineering" Woodhead Publishing, 2005.

REFERENCES

1. Gary E. Wnek, Gary L Browlin , "Encyclopedia of Biomaterials and Biomedical Engineering",Marcel Dekker Inc, New York, 2008.
2. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013.
3. Bernhard O. Palsson, Sangeeta N. Bhatia, " Tissue Engineering" , Pearson 1st Edition, 2016.
4. S. Malik and A. Dhasmana , " Stem Cell and Tissue Engineering" , Sankalp Publication, 2020.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2				3	2			2					3
CO2	2				2	2	2		2					2
CO3	2				3	3				3		2	2	
CO4	2				3	3	1						3	
CO5	2				3	2				2		3		2



BM20353 **TELEHEALTH TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- study the series, history and evolution of telemedicine
- teach the functional diagram of telemedicine system
- teach the concept about telemedical data security and standards
- know about the Social and legal issues, Safety and regulatory issues and advances in telemedicine.
- gain knowledge about the health education and self care services

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; 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 **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; Real-time Telemedicine integrating doctors /Hospitals.

UNIT IV MOBILE TELEMEDICINE **9**

Tele radiology - Definition, Basic parts of tele radiology system; Tele pathology; multimedia databases - color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color; Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment; Hospital information system - Doctors, paramedics, facilities available; Pharmaceutical information system.

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.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- illustrate the concept of telehealth, telecare and organs of telemedicine.
- relate the principles of multimedia and networks.
- recognize the protocols and standards to be followed.
- analyze the basic parts of teleradiology system.
- demonstrate robotics surgery, tele surgery, tele cardiology and teleoncology.

TEXT BOOKS

1. R.S.Khandpur "Telemedicine Technology and Applications (mhealth, Telehealth and ehealth)", PHI Learning Pvt.Ltd, Delhi, 2017.
2. 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.

REFERENCES

1. Norris, A.C. Essentials of Telemedicine and Telecare. Wiley (ISBN 0-471-53151-0), 2002.
2. Victor Lyuboslavsky, "Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients", CreateSpace Independent Publishing Platform, 1st edition, 2015.
3. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.
4. Simpson, W. 2006. "Video over IP- A practical guide to technology and applications", Focal Press(Elsevier). ISBN-10: 0-240-80557-7.

CO/PO MAPPING :

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs		Programmes Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3		3	2						2		3
CO2	3		3		2	2								2
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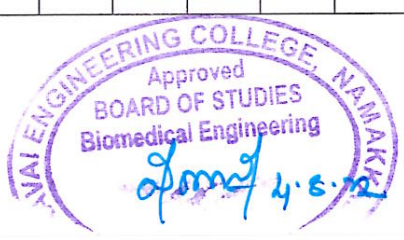
CO4	2		3		3	3						3	3	
CO5	2		3		3	2								2



BM20354 DESIGN AND DEVELOPMENT OF MEDICAL DEVICES 3 0 0 3

COURSE OBJECTIVES

To enable students to

- introduce the basic design of medical device.
- learn the fundamental concepts of physiological parameters measurement
- study the minimally invasive device and cardiac vascular system instrumentation
- study in detail about system description of respiratory system
- apply the concepts of various instrumentation techniques for neurological equipments

UNIT I INTRODUCTION TO MEDICAL DEVICE 9

Define medical device; Classification of medical device; Medical device vs medical instrumentation; Origin of bio-potential - Physiological signal; Human machine interface - Input, output and control signal, Data acquisition, Sensor, Amplification; Medical electrical stimulator.

UNIT II ADVANCED MEDICAL INSTRUMENTATION 9

Design of instrumentation system for physiological measurements - temperature, pressure, strain, weight, angle measurements using encoder, flow measurements; Sensor selection for speed, location and acceleration measurement; Case study.

UNIT III CARDIOVASCULAR SYSTEM AND INSTRUMENTATION 9

Design of instrumentation system for Blood pressure measurement - selection of sensors, design specifications, blood flow measurements; phonocardiography; Cardiac pacemakers; heart lung machines; Tread Mill; Test design of interfacing circuits - Design of interface system; Case study.

UNIT IV RESPIRATORY SYSTEM AND INSTRUMENTATION 9

Mechanics of breathing - regulation of respiration, design of instrumentation system for respiratory system; selection of transducers; artificial respiration therapy; artificial mechanical ventilation - troubleshooting and maintenance of ventilators; Design of interfacing circuits; Case study.

UNIT V NEUROLOGICAL INSTRUMENTATION SYSTEM 9

Neurophysiology - design of EEG amplifiers, wireless EEG, Bispectral Index EEG measurements for depth of anesthesia monitoring.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- describe the basic design of medical device.
- construct the suitable instrumentation technique for a specific illness.
- categorize the medical devices based on its biomedical applications.
- relate the various parameters, constraints in methodology for effective diagnosis.
- design advanced biomedical equipments for various diseases and ensure patient safety.

TEXT BOOKS

1. Steven Schreiner, Joseph D. Bronzino, Donald R. Peterson, "Medical Instruments and Devices: Principles and Practices", CRC Press, 2017.
2. Joseph J Carr, John M Brown, "Introduction to medical equipment technology", Pearson education publisher, New Delhi, 2013.

REFERENCES

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.
2. Anthony Y. K. Chan, Biomedical device technology: principles and design ,Charles Thomas, 2008.
3. Theodore R, Kucklick, The Medical Device Ramp-D Handbook, Taylor and Francis Group LLC, 3rd edition 2013.
4. David Prutchi, Michael Norris, Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design, construction and test of medical devices, John Wiley and Sons, 2005.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak													
COs		Programmes Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3		3	2						2		3
CO2	2	3	3		2	2					2	2		2
CO3	2	2	2		3	3					2	3	2	
CO4	2		3		3	3					3	3	3	
CO5	2		3		3	2						3		2

BM20451 **MEDICAL OPTICS AND LASER APPLICATIONS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- provide a possibility for the student to acquire knowledge about the impact and interaction of light with biological tissue
- gain knowledge about the fiber optic sensors
- study about optical coherence tomography
- understand the engineering and practical applications of optics related to diagnostics, sensing and therapeutics of the human body
- understand clinical applications of laser

UNIT I INTRODUCTION TO BIOPHOTONICS **9**

Basic properties of light - Reflection, Refraction, Scattering, fluorescence and phosphorescence; Instrumentation for absorption, scattering and emission measurements; Optical sources - high pressure arc lamp, LEDs, Medical Lasers.

UNIT II OPTICAL PROPERTIES OF THE TISSUES **9**

Optical properties of tissue - melanin, bilurubin, tissue and their spectrum; optical characteristics of constituents of blood - RBC, hemoglobin properties, plasma, oxygenated and deoxygenated hemoglobin; Laser tissue Interaction -Chemical, Thermal, Electromechanical.

UNIT III DIAGNOSTIC APPLICATIONS **9**

Wood's lamp; Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, FLIM, FRAP, FRET, Raman Spectroscopy and Imaging, NIRS; Applications.

UNIT IV NON THERMAL DIAGNOSTIC APPLICATIONS **9**

Optical filters; Optical detectors - Time resolved and phase resolved detectors; optical tweezers - Holographic and speckle application of lasers in biology and medicine; Photodynamic therapy (PDT).

UNIT V LASER APPLICATIONS **9**

Principles of Laser action; Different types - CO2, Nd- YAG, Argon, Helium-Neon; Clinical applications of laser - Endoscopy, Laparoscopy; Surgical applications of lasers - Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology; Tissue welding; Laser safety.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- categorize the photonics instruments.
- classify the various optical properties of tissue.
- demonstrate the application of diagnostic and applications of lasers in medical fields
- model the application of therapeutic and surgical applications of lasers in medical fields.
- design and implement fiber optic sensors used in medical application.

TEXT BOOKS

1. Markolf H.Niemz, Laser-Tissue Interaction Fundamentals and Applications‖, Springer,2007.
2. Paras N. Prasad, Introduction to Biophotonics‖, JohnWileyandsons,Inc.Publications,2003.

REFERENCES

1. TuanVoDinh,Biomedical photonics–Handbook‖,CRCPressLLC,2003.
2. Mark E. Brezinski, Optical Coherence Tomography: Principles and Applications, Academic Press, 2006.
3. R.Splinter and B.A.Hooper, An Introduction to Biomedical Optics, Taylor and Francis, 2007.
4. Helena Jelinkova, " Lasers for Medical Applications" , 1st Edition, 2013.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3	2						2		3
CO2	2		3		2	2						2		2
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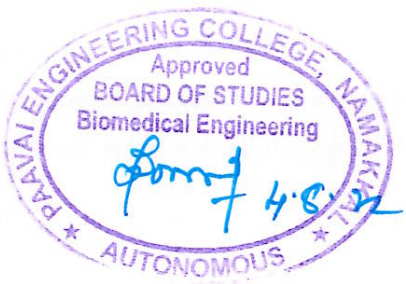
CO4	2		3		3	3						3	3	
CO5	2		3		3	2						3		2



BM20452 **MEDICAL ETHICS STANDARDS AND SAFETY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- achieve familiarity with some basic ethical framework& understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- know about Medical Standards and Regulations
- know about the legal and ethical principles and application of these principles in health care settings
- gain knowledge about the medical standards that to be followed in hospitals.
- learn about suitable principles of medical equipment safety standards in hospitals

UNIT I INTRODUCTION TO MEDICAL ETHICS **9**

Definition of Medical ethics; Scope of ethics in medicine; International code of Ethics for occupational health professionals - CMA code of ethics; Fundamental Responsibilities - The Doctor and The Patient, The Doctor and The Profession; Professional Independence - The Doctor And Society.

UNIT II CODE OF ETHICS FOR BIOMEDICAL ENGINEERS **9**

Bioethics - The principle of Double effect, Code of Hammurabi, Engineering Competence; Ethical Issues in biomedical research - Cloning and stem cell research, Neuro ethic; Organ Transplantation; Hypothetic co-deductive method; Research Conflict of Interest; Medical device failure - Five failure types; Bio-terrorism; Sustainable Bioethics - Life cycles and Concurrent Engineering, Environmental Health; case studies.

UNIT III MEDICAL DEVICES STANDARDS **9**

Medical Standards and Regulations - Device classification, Registration and listing, Declaration of conformance to a recognized standard, Investigational Device Exemptions; Institutional Review Boards - IDE format, Good laboratory practices, Good manufacturing practices.

UNIT IV HOSPITAL SAFETY STANDARDS **9**

Life Safety Standards - Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Protecting Individuals From Fire and Smoke; 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 HOSPITAL ACCREDITATION STANDARDS 9

Accreditation - JCI Accreditation & its Policies; Patient centered standards; Healthcare Organization management standards; Indian Perspective.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- apply legal and professional guidelines for the health professions.
- perform social responsibility in healthcare systems.
- categorize bioethics and engineers role.
- illustrate medical device maintenance.
- perform safety aspects.

TEXT BOOKS

1. William Charney, "Handbook of Modern Hospital Safety'', CRC Press, 2nd Edition, 2009.
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, "Inspection of Medical Devices: For Regulatory Purposes", Springer Nature, 2018.

REFERENCES

1. Eileen E.Morrison, "Ethics in Health Administration: A Practical Approach for Decision Makers'',Jonnes and Bartletts' Publication, 2nd Edition, 2011.
2. Robert M Veatch, "Basics of Bio Ethics'', Prentice- Hall, Inc., 2nd Edition, 2003.
3. Joint Commission Accreditation Standards for Hospitals ,2nd Edition, 2003.
4. Domiel A Vallero , "Biomedical Ethics for Engineers", Elsevier Pub.1st Edition, 2007.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3		3	2		2				2		3
CO2	3		3		2	2		3				3		2
CO3	2				3	3						2	2	
CO4	2				3	3		2				3	3	
CO5	2				3	2						3		2

BM20453 **ADVANCED HEALTHCARE SYSTEM DESIGN** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the needs for wearable devices and the technology
- learn the needs for wearable devices and the technology
- study the tools in design, testing and developing digital health care equipment
- know about the tools and methods of work flow
- gain knowledge about the quality and safety standards for developing healthcare systems

UNIT I **WEARABLE DEVICES AND M-HEALTH CARE** **9**

Introduction to mobile health care - devices, economy, average length of stay in hospital, outpatient care; Health care costs - mobile phones, 4G, smart devices, wearable devices; Uptake of e-health and m-health technologies.

UNIT II **DIGITAL RADIOLOGY** **9**

Digital radiology for digital hospital; Picture archiving and communication; System integration; Digital history of radiology - Medical image archives, storage and networks.

UNIT III **E-HEALTH** **9**

Health care networking - Medical reporting using speech recognition, physiological tests and functional diagnosis with digital methods; Tele-consultation in medicine and radiology.

UNIT IV **MODALITY AND DIGITAL HEALTH** **9**

Multimodality registration in daily clinical practice; Mobile healthcare - Requirements and best practices, Laws and regulations in Digital health; Ethical issues - barriers and strategies for innovation.

UNIT V **STANDARDS FOR INTER OPERABILITY** **9**

Selection and Implementation in e-Health project - design of medical equipments based on user needs; Security and privacy in digital health care.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- identify the available technology for wearable healthcare devices
- interpret the need for digital methods of handling medical records
- modify the tools and methods for work flow
- compare various standards for inter-operability of devices
- decide quality and safety standards for developing healthcare systems

TEXT BOOKS

1. Khandpur.R.S. "Handbook of Biomedical Instrumentation". Third edition Tata McGraw Hill Pub. Co. Ltd., 2015.
2. Wlater Hruby, " Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006.

REFERENCES

1. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015.
2. John,G.Webster. MedicalInstrumentation: Application and Design, SecondEdition. Wiley Publisher, New Delhi. 2013.
3. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", Springer, 1st ed. 2017
4. Joseph J. Carr and John M. Brown, "Introduction Biomedical Equipment Technology", pearson 4th Edition, 2002.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3	3					2	3	3	3
CO2	2		3		3	3					2	2	3	2
CO3	3		3		3	2					3	2	3	
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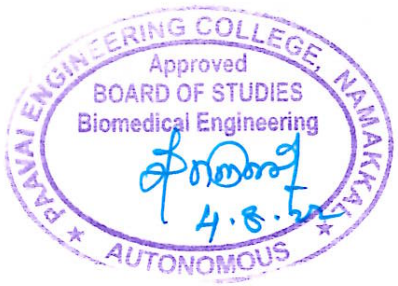
CO5	3		3		2	3					3	3	3	2



BM20454 **ARTIFICIAL INTELLIGENCE FOR BIOMEDICAL ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the basic knowledge on Neural networks
- learn the fuzzy logic control
- study the concept of Genetic algorithm
- learn the analysis of PSO and DE optimization techniques
- study the concept of AI in medicine.

UNIT I INTRODUCTION TO NEURAL NETWORKS **9**

Basics of ANN - Perceptron, Delta learning rule, Back propagation algorithm; Multilayer Feed forward network; Memory models - Bi-directional associative memory; Hop field network; Kohonen self-organizing; ART network.

UNIT II FUZZY LOGIC CONTROL **9**

Classical set Vs Fuzzy set - Operation and Properties; Fuzzy Relation - Fuzzy Logic control, Fuzzification, Membership functions, Defuzzification; Rule Based System and Applications; Decision making control through fuzzy set theory.

UNIT III GENETIC ALGORITHM **9**

Genetic algorithm and search space - General genetic algorithm, Operators in GA, genetic programming; Multilevel optimization; Advances in GA.

UNIT IV PSO and DEOPTIMIZATION TECHNIQUE **9**

Introduction - Review on PSO and DE, Restoration using particle, swarm optimization and differential evolution techniques; Formulation; Application.

UNIT V APPLICATIONS IN MEDICINE **9**

Diagnosis of disease using AI; Biometrics - Face recognition and Gene matching; Automated drug delivery systems; Computer aided diagnosis - Mining of electronic health record, Computer vision.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- represent the neural network in various forms.
- elucidate the fuzzy logic operations and application of AI in decision making.
- examine the application of genetic algorithm.
- analyze the PSO and DE techniques.
- implement the AI in medicine.

TEXT BOOKS

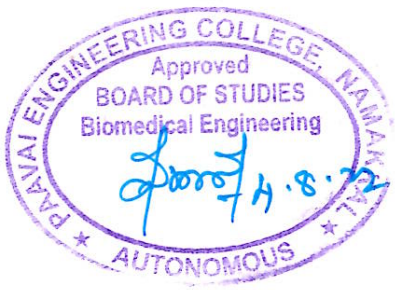
1. James. A. Freeman and B. M. Skapura – "Neural Networks, Algorithms Applications and Programming techniques"- Addison Wesley, 2000.
2. Zimmerman, H.J. -"Fuzzy Set Theory and its Applications", Kluwer Academic Publishers, 2004.

REFERENCES

1. George Klir and Tina Folger,.A., - "Fuzzy sets, Uncertainty and Information", Prentice Hall of India Pvt.Ltd., 2002 .
2. S.Rajasekaran and G A Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall, India, 2003.
3. David E. Goldberg, "Genetic Algorithm in Search Optimization and Machine Learning" Pearson Education India, 2013.
4. Carlo Combi, Yuval Shahar; "Artificial Intelligence in Medicine" – 12 th Conference – pringer

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		**Programmes Outcomes(POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3		3	3	3	3			2			3	3	
CO2	2		3	3	3	3			2			2	3	
CO3	3		3	2	3	2						2	3	
CO4	2		3	3	3	2			2			3	3	
CO5	3		3	3	2	2						3	3	



BM20551 **ARTIFICIAL ORGANS AND IMPLANTS** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- have an overview of artificial organs and transplants.
- describe the principles of implant design with a casestudy.
- explain the implant design parameters and solution inuse.
- study about various blood interfacing implants.
- study about soft tissue replacement and hard tissue replacement.

UNIT I ARTIFICIAL ORGANS AND TRANSPLANTS **9**

Introduction; outlook for organ replacements; design consideration; evaluation process; Transplants - Overview, Immunological considerations, Blood transfusions; Individual organs - kidney, liver, heart and lung, bone marrow, cornea.

UNIT II PRINCIPLES OF IMPLANT DESIGN **9**

Principles of implant design; Clinical problems requiring implants for solution; Permanent versus absorbable devices; The missing organ and its replacement; Tissue engineering - scaffolds, cells and regulators criteria for materials selection; Case study of organ regeneration.

UNIT III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION **9**

Biocompatibility; local and systemic effects of implants; Design specifications for tissue bonding and modulus matching; Degradation of devices - natural and synthetic polymers, corrosion, wear and tear; Implants for Bone; Devices for nerve regeneration.

UNIT IV BLOOD INTERFACING IMPLANTS **9**

Neural and neuromuscular implants; Heart valve implants; Heart and lung assist devices; Artificial heart - Cardiac pacemakers, artificial kidney, dialysis membrane and artificial blood.

UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS **9**

Gastrointestinal system; Dentistry; Maxillofacial and craniofacial replacement - Soft tissue repair, replacement and augmentation; recent advancement and future directions.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- classify artificial organs & transplants.
- formulate implant design and its parameters.
- summarize blood interfacing implants.
- compare different types of soft tissue replacement and hard tissue replacement.
- perform the applications of implantable medical devices and organs.

TEXT BOOKS

1. Nadey S. Hakim, "Artificial Organs, Springer London", 28 Oct 2010.
2. Park J.B, "Biomaterials Science and Engineering", Springer US, 23 Jan 2014.

REFERENCES

1. J D Bronzino, Biomedical Engineering Handbook, Fourth Edition, (CRC Press), 3 Oct 2018.
2. R S Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 16 June 2014.
3. Roderic S. Lakes, Joon B Park, Biomaterials – An Introduction, Springer US , 28 Nov 2012.
4. Yannas, I. V, "Tissue and Organ Regeneration in Adult", New York, NY: Springer, 2001. ISBN:9780387952147.

CO/PO MAPPING :

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COs		Programmes Outcomes(POs)												
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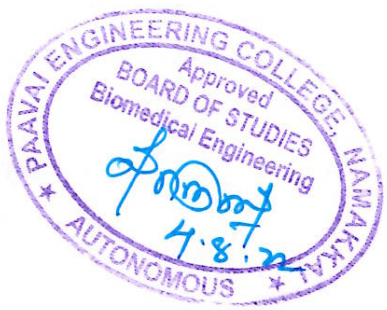

EMBEDDED SYSTEMS AND INTERNET OF THINGS IN HEALTHCARE

BM20552 **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- learn the internal architecture and programming of an embedded processor.
- introduce interfacing I/O devices to the processor.
- introduce the evolution of Internet of Things(IoT).
- build a small low-cost embedded and IoT system using Arduino/RaspberryPi/openplatform.
- apply the concept of Internet of Things in real world scenario.

UNIT I 8-BIT EMBEDDED PROCESSOR 9

8-Bit Microcontroller - Architecture, Instruction Set and Programming; Programming Parallel Ports - Timers and Serial Port; Interrupt Handling.

UNIT II EMBEDDED C PROGRAMMING 9

Memory And I/O Devices Interfacing; Programming Embedded Systems in C; Need For RTOS - Multiple Tasks and Processes, Context Switching, Priority Based Scheduling Policies.

UNIT III INTERNET OF THINGS AND PROCESSORS 9

ARM Processor - Introduction to the Concept of IoT Devices, IoT Devices Versus Computers, IoT Configurations; Basic Components; Introduction to Arduino - Types of Arduino, Arduino Toolchain, Arduino Programming Structure, Sketches, Pins, Input/Output from pins using sketches; Introduction to Arduino Shields - Integration of Sensors and Actuators with Arduino.

UNIT IV INTERNET OF THINGS COMMUNICATION AND OPEN PLATFORMS 9

IoT Communication Models and APIs; IoT Communication Protocols; Bluetooth; WiFi; ZigBee; GPS; GSM modules; Open Platform (like Raspberry Pi) - Architecture, Programming, Interfacing, Accessing GPIO Pins, Sending and Receiving Signals Using GPIO Pins, Connecting to the Cloud.

UNIT V APPLICATIONS DEVELOPMENT 9

Complete Design of Embedded Systems; Development of IoT Applications - Home Automation, Smart Agriculture, Smart Cities, Smart Healthcare.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- summarize and compare various embedded processors.
- design and deploy timers and interrupts.
- develop embedded C programs.
- design simple embedded applications.
- build portable IoT using Arduino/Raspberry Pi /open platform.

TEXT BOOKS

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014.
2. Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", John Wiley & Sons, 2014.

REFERENCES

1. Michael J. Pont, "Embedded C", Pearson Education, 2007.
2. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
3. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
4. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.

CO/PO MAPPING :

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs		Programmes Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3	3	3			2			3	3	
CO2	2		3	3	3	2			2			2	3	
CO3	3		3	2	3	3			3			2	3	
CO4	2		3	3	3	2			2	3		3	3	
CO5	3		3	3	2	3			3	3		3	3	

BM20553 **PHYSIOLOGICAL MODELLING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the application of Physiological models and Vital organs.
- understand methods and techniques for analysis and synthesis of dynamic models
- model dynamically varying physiological system
- develop differential equations to describe the dynamic models
- simulate and visualize, dynamic responses of physiological models using software

UNIT I SYSTEM CONCEPT **9**

Introduction to Physiological control systems - Purpose of physiological modeling and signal analysis; Illustration- example of a physiological control system; Difference between engineering and physiological control systems; System variables and properties - Resistance, both static and dynamic, Compliance and combination of resistance and compliance; Resistance and compliance models - respiratory system, aortic segments, lumped model of physiological thermal system, and step response of resistance, compliance system; dye dilution study of circulation.

UNIT II SYSTEM ANALYSIS **9**

Review of transfer function - transfer function of coupled system, Impedance based transfer function; flexible tube feeding a single port compliant model - development of a lung model; Periodic signals - sinusoidal analysis of second order system, analysis of respiratory system based on sinusoidal excitation; pendelluft.

UNIT III TRANSIENT AND FEEDBACK **9**

Review of transient and stability analysis - Homeostasis, representation, finger tracking; Characterization of Physiological Feedback systems - Hypophysis adrenal systems, Nonlinear systems and linearization; transfer function analysis of pupillary control system as a closed loop and method of opening the closed loop, pupillary hippus.

UNIT IV MODELING OF CARDIOPULMONARY SYSTEM **9**

Model of cardiac output regulation - Starling's law, Physical Significance of under damped responses of post systolic operations in aortic arch, model of circadian rhythms, chemical regulation of ventilation; Cheyne-Stoke breathing; biot breathing.

UNIT V OTHER PHYSIOLOGICAL MODELS AND SIMULATION **9**

Introduction to digital control system; Steady state analysis of regulation of glucose; Hodgin-Huxley model; Thermal system - model and simulation; modeling of eye movement - types of eye movement, saccade model, model of occulomotor control.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- compose application of Physiological models.
- model dynamically varying physiological system.
- analyze and synthesize dynamic models of physiological system
- develop differential equations to describe the dynamic models, simulate and visualize.
- implement physiological models using software to get dynamic responses.

TEXT BOOKS

1. William B.Blesser, "A System Approach to Biomedicine", McGraw Hill Book Co., New York, 1969.
2. Micheal C.K.Khoo ,"Physiological Control System Analysis, Simulation and Estimation", Prentice Hall of India , New Delhi ,2001.

REFERENCES

1. Manfreo Clynes and John H.Milsum, "Biomedical Engineering System", McGraw Hilland Co., New York ,1970
2. Richard Skalak and ShuChien, "Hand Book of Biomedical Engineering" , McGraw Hilland Co., New York, 1987
3. Douglas S.Rigg, "Control Theory and Physiological Feedback Mechanism", The Wilkliam and Wilkins Co. Baltimore, 1970.
4. Joseph D,Bronzino, "'The Biomedical Engineering Handbook'', CRC Press,3 rd Edition, 2006.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3	3	3			2	3		3	3	
CO2	2		3	3	3	3			2	3		2	3	
CO3	3		3	2	3	3				2		2	3	
CO4	2		3	3	3	3			2	2		3	3	
CO5	3		3	3	2	3				2		3	3	

BM20554 ROBOTICS AND AUTOMATION IN MEDICINE 3 0 0 3

COURSE OBJECTIVES

To enable students to

- explain the basic concepts of robot sand types of robots
- discuss the designing procedure of manipulators, actuators and grippers.
- impart knowledge on various types of sensors and power sources.
- gain knowledge on assistive robots.
- explore various applications of Robots in Medicine.

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.

UNIT II MANIPULATORS AND BASIC KINEMATICS 9

Construction of Manipulators - Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems; Solutions of Inverse Kinematic problems.

UNIT 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.

UNIT IV REHABILITATION AND ASSITIVE 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.

UNIT V WEARABLE ROBOTS 9

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.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- demonstrate the configuration, applications of robots and the concept of grippers and actuators.
- elucidate the functions of manipulators and basic kinematics.
- analyze the application of robots in various surgeries
- design and analyze the robotic systems for rehabilitation.
- design the wearable robots.

TEXT BOOKS

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008.

REFERENCES

1. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016.
2. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011.
3. Jocelyn Troccaz, Medical Robotics, Wiley, 2012.
4. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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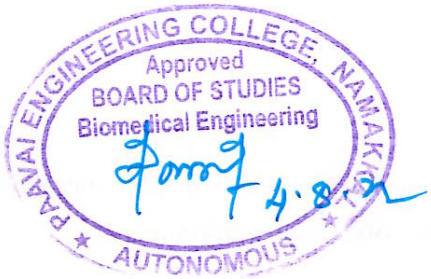
CO2	2	2	3		3	3			2		3	2	3	
CO3	3	3	3		3	2		2			3	2	3	
CO4	2	2	3		3	3		2			2	3	3	
CO5	3	3	3		2	3		3			2	3	3	



BM20651 **VIRTUAL REALITY IN MEDICINE** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- give the basic introduction about virtual reality in medicine
- impart the fundamental in different modeling techniques
- know the human factors in virtual reality technology.
- understand the basics of VR Programming
- gain knowledge about applications of virtual reality.

UNIT I INTRODUCTION **9**

The three I's of virtual reality; commercial VR technology and the five classic components of a VR system; Input Devices (Trackers, Navigation, and Gesture Interfaces) - Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces; Output Devices - Graphics displays, sound displays and haptic feedback.

UNIT II MODELING **9**

Geometric modeling - kinematics modeling, physical modeling, behavior modeling; model management.

UNIT III HUMAN FACTORS **9**

Methodology and terminology - user performance studies, VR health and safety issues, Usability of virtual reality system; cyber sickness - side effects of exposures to virtual reality environment.

UNIT IV VR PROGRAMMING **9**

Introducing Java 3D - loading and manipulating external models, Using a lathe to make shapes; 3D Sprites - animated 3D sprites, particle systems.

UNIT V APPLICATIONS **9**

Medical applications; Robotics applications; Advanced Real time Tracking; other applications - games, movies, simulations, therapy.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- comprehend and appreciate the significance and role of this course in the present contemporary world.
- understand the basic concepts of Virtual reality
- expose the concept of Virtual Reality Programming with toolkits.
- design of various modeling concepts.
- develop the Virtual Reality applications in different areas.

TEXT BOOKS

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. Andrew Davison, "Killer Game Programming in Java", Oreilly SPD, 2005.

REFERENCES

1. John Vince, "Introduction to Virtual Reality", Springer-Verlag Ltd., 2004.
2. William R.Sherman, Alan B.Craig, "Understanding Virtual Reality – Interface, Application, Design", The Morgan Kaufmann Series, 2003.
3. Robert Riener, Matthias Harders, "Virtual Reality in Medicine", Springer, 2012.
4. Grigore C. Burdea, Philippe Coiffet, " Virtual Reality Technology", Wiley – IEEE Press, 2nd Edition , 2003.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
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CO1	3	3	3		3	3			3		2	3	3	
CO2	2	3	3		3	2		2	2		2	2	3	
CO3	3	2	3		3	2		3			3	2	3	
CO4	2	2	3		3	3		2			2	3	3	
CO5	3	2	3		2	2					3	3	3	

BM20652 WEARABLE DEVICES AND ITS APPLICATION 3 0 0 3

COURSE OBJECTIVES

To enable students to

- learn the fundamentals of sensors.
- understand signal processing association in wearable systems.
- evaluate various energy needs in wearable.
- learn the analysis of wearable systems.
- analyze the applications of wearable.

UNIT I SENSORS **9**

Need for wearable systems - Sensors for wearable systems, Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, Pneumography; Wearable ground reaction force sensor - GSR, Radiant thermal sensor, Wearable motion sensors, CMOS Based Biosensors; E-Textiles; Bio compatibility.

UNIT II SIGNAL PROCESSING **9**

Wear ability issues - Physical shape and placement of sensor; Technical challenges - Sensor design, Signal acquisition, Constraint on sampling frequency for reduced energy consumption; Light weight signal processing, Rejection of irrelevant information, Data mining.

UNIT III ENERGY HARVESTING FOR WEARABLE DEVICES **9**

Solar cell; Vibration based Thermal based Human body as a heat source for power generation; Hybrid thermoelectric photovoltaic energy harvests; Thermopiles.

UNIT IV WIRELESS HEALTH SYSTEMS **9**

Need for wireless monitoring - Definition of Body area network, BAN and Healthcare, Technical Challenges, System security and reliability; BAN Architecture - Introduction, Wireless communication techniques.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS **9**

Medical Diagnostics; Medical Monitoring - Patients with chronic disease, Hospital patients, Elderly patients; Multi parameter monitoring - Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- describe the principles of various types of sensors.
- apply appropriate sensors and signal processing techniques for wearable systems.
- categorize the energy requirement for a wearable system.
- compare the security issues related to wearable systems.
- expose the application of wearable systems.

TEXT BOOKS

1. Annalisa Bonfiglio,Danilo De Rossi ,"Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkata Subramanian, "Body Area Networks Safety,Security, and Sustainability," Cambridge University Press, 2013.

REFERENCES

1. Hang,Yuan-Ting,"wearable medical sensors and systems",Springer-2013.
2. Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications",Pan Stanford Publishing Pvt.Ltd, Singapore, 2012.
3. Guang-Zhong Yang(Ed.), "Body Sensor Networks, "Springer, 2006.
4. Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalized Health Management – State of the art and future challenges ' IOS press, The Netherlands, 2004.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak													
COs		Programmes Outcomes(POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3	3		3				3	3	
CO2	2		3		3	3		3				2	3	
CO3	3		3		3	2		2				2	3	
CO4	2		3		3	3		2				3	3	
CO5	3		3		2	3		2				3	3	

BM20653 QUALITY CONTROL IN BIOMEDICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- learn overview of various methodologies used for management in health care
- understand the various quality standards and regulations used for health care.
- gain the knowledge about management methodologies in medical Engineering.
- achieve the various tools.
- gain knowledge in regulatory bodies.

UNIT I INTRODUCTION **9**

Philosophy of Quality Management; Customer Focus; Top Management Commitment - Teamwork; Quality control Tools - Problem solving methodologies, New Management Tools, work habits, Strategic Quality planning.

UNIT II DEVELOPMENT SYSTEM IN QUALITY **9**

Quality policy development; Quality function development - Designing for Quality, Manufacturing for Quality; Environment Management Systems.

UNIT III QUALITY STANDARDS **9**

Need for standardization - Regional, National, International standardization; Classification of equipment - Methods of Testing standardization, Maintenance of standardization and Recalibration; Quality system - Elements, implementation of quality system, Documentation, Quality auditing.

UNIT IV QUALITY REGULATION **9**

FDA Regulations; Joint Commission; Accreditation of hospitals; other Regulatory codes - NABA, JCI, NABL, NABH.

UNIT V REGULATORY BODIES **9**

International Standards ISO 9000, 9004; Features of ISO 9001, ISO 14000, ISO 13485; Need for ISO 9000 System - Advantages, clauses of ISO 9000, Implementation of ISO 9000, Quality costs; Case studies.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- determine the various methodologies used for management in health care.
- apply the quality development in medical field.
- demonstrate the quality standards.
- determine the management methodologies in medical engineering.
- identify the regulatory bodies.

TEXT BOOKS

1. Sunil Luthra, Dixit Garg, Ashish Agarwal, Sachin K. Mangla, "Total Quality Management (TQM) Principles, Methods, and Applications ", CRC Press., 2020.
2. Ernesto Iadanza, "Clinical Engineering Handbook", Elsevier Science, 2019..

REFERENCES

1. Walter A. Shewhart, "Economic Control of Quality of Manufactured Product", Martino Publishing, 2015.
2. Paul Ganney, Richard Axell, "Clinical Engineering - A Handbook for Clinical and Biomedical Engineers", Elsevier Science, 2019.
3. G.D.Kunders,"Hospitals–Facilities Planning andManagement",TMH,NewDelhi –5th edition Reprint 2007
4. R.C.Goyal,"Hospital Administration and Human Resource Management", PHI 4thEdition, 2006.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
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CO3	3	3	3		3	2			2		2	2	3	
CO4	2	2	3		3	2			3		3	3	3	
CO5	3	3	3		2	2			2		3	3	3	

BM20654 **MEDICAL RADIATION SAFETY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- enhance knowledge on radiation.
- understand the importance of detecting radiation levels.
- be aware of nuclear medicine and its precautions.
- understand safety measures on laser and UV.
- evaluate the need of dosimetry.

UNIT I **INTRODUCTION TO RADIO FREQUENCY AND MICROWAVE RADIATION** **9**

Sources of radio frequency radiation - Effects of radio frequency radiation; Development of standards for human safety; Calculation of RF field quantities; RF radiation measuring instruments and methods.

UNIT II **RADIATION DETECTION AND MEASUREMENT** **9**

Fundamentals of radiation detection - Conducting radiation measurements and surveys, Gas detectors, Designing to reduce radiation hazards, Radio frequency radiation safety management and training, Scintillation detectors; Statistics of counting - minimum detectable activity, Quality assurance of radiation counters; International Commission on Radiation Protection (ICRP); Nuclear Regulatory Commission (NRC).

UNIT III **RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY** **9**

Design and description of NM department; Radiation protection in nuclear industry - Guidelines for radiation protection; Molecular medicine and radiation safety program - procedures for safe operation of radiation equipment, Radiation protection in external beam radiotherapy, Radiation protection in brachytherapy Radioactive wastes.

UNIT IV **LASER AND ULTRAVIOLET RADIATION SAFETY** **9**

Classification of UV radiation - Sources of UV, Biological effects of UV, Hazards associated with UV radiation, UV control measures; Safety management of UV; Classifications of LASER and its radiation hazards - control measures Emergencies and incident procedures; The ALARA Policy; Radiation Safety Practices - RSO,RSC,RSP,QMP.

UNIT V **MONITORING AND INTERNAL DOSIMETRY** **9**

Monitoring methods - personal radiation monitoring; Records of personal dosimetry - ICRP method, MIRD method, Internal doses from radiopharmaceuticals, Bioassay of radioactivity; Hazard and risk in

radiation protection - radiological incidents and emergencies; Regulation to radiation protection; Recommended Dose Limits - Occupational, General Public Dose Limits.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- summarize the basics of radiation physics.
- demonstrate the guidelines of radiation protection and radiation detectors.
- apply nuclear medicine protocols.
- illustrate safety measures related to UV, laser and nuclear medicine.
- determine the records of dosimetry

TEXT BOOKS

1. Khandpur.R.S. "Handbook of Biomedical Instrumentation". Third edition Tata McGraw Hill Pub. Co. Ltd., 2013
2. Alan Martin, Samuel Harbison, Karen Beach, Peter Cole, Hodder Arnold, "An Introduction to radiation protection", 6th edition 2012.

REFERENCES

1. Max Hlombardi, "Radiation safety in nuclear medicine", CRC Press Taylor & Francis group, 2nd edition, 2007.
2. Aruna Kaushik, Anupam Mondal, Dwarakanath B.S, Tripathi R P, "Radiation protection manual", INMAS, DRDO, 2010.
3. Ronald kitchen, "RF and microwave radiation safety", Newness publishers, 2nd edition, 2001.
4. Jamie V, Trapp, Thomas Kron, "An introduction to radiation protection in medicine", CRC press Taylor &Francis group, 2008.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
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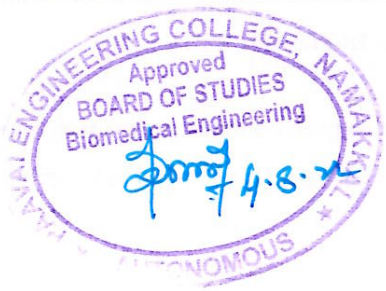
CO1	3		3		3	3						3	3	
CO2	2		3		3	3						2	3	
CO3	3		3		3	2						2	3	
CO4	2		3		3	2						3	3	
CO5	3		3		2	2						3	3	



BM20903 **BASICS OF TELEMEDICINE** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- introduce the key principles of telemedicine and health
- access of medical records and to know about data protection and security
- understand telemedical technology
- learn telemedical standards and its application
- study the applications of telemedicine

UNIT I INTRODUCTION TO TELEMEDICINE **9**

History and Evolution of telemedicine - Functional diagram of telemedicine system, Essential Parameters for Telemedicine; Delivery Modes in Telemedicine; Benefits and Limitations of Telemedicine.

UNIT II ETHICAL , SECURITY AND LEGAL ASPECTS OF TELEMEDICINE **9**

Confidentiality, patient rights and consent - confidentiality and the law, the patient-doctor relationship, access to medical records; consent treatment - data protection and security, jurisdictional issues, intellectual property rights; Security in Telemedicine systems - Access control, Fire wall, Encryption, Authentication, Digital certificate, Digital Timestamp.

UNIT III TELEMEDICAL TECHNOLOGY **9**

Principles of Multimedia - Text, Audio, Video, data, PSTN, POTS, ANT, ISDN, Internet; Wireless Communication - GSM satellite, and Micro wave; Modulation techniques; Types of Antenna; Satellite communication; Mobile hand-held devices and mobile communication; Internet technology and telemedicine using worldwide; Video and audio conferencing.

UNIT IV DATA SECURITY AND STANDARDS **9**

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).

UNIT V APPLICATION OF TELEMEDICINE **9**

Telemedicine access to health care services - health education and self-care; Introduction to robotics surgery - Telesurgery; Teleradiology; Telepathology.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- discuss the concepts of telemedicine
- interpret the legal aspects of telemedicine
- illustrate multimedia technologies in telemedicine
- analyze data acquisition and the data storage devices
- apply telehealth in healthcare

TEXT BOOKS

1. Olga Ferrer Roca, M.SosaIudicissa , "Hand book of Telemedicine", IOS press, 2002.
2. Norris.A.C, "Essentials of Telemedicine and Telecare", John Sons & Ltd, 2002.

REFERENCES

1. R.S.Khandpur "Telemedicine Technology and Applications (mhealth, Telehealth and ehealth)", PHI Learning Pvt.Ltd, Delhi 2017.
2. Wootton, R., Craig, J., Patterson, V., "Introduction to Telemedicine. Royal Society of Medicine" Press Ltd, Taylor & Francis 2006.
3. Bashshur, R.L., Shannon G.W. "History of Telemedicine", New Rochelle NY: Mary Ann Liebert Publishers, 2009.
4. Shashi Gogia, "Fundamentals of Telemedicine and Telehealth", Academic press 2019.

CO/PO MAPPING :

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CO3	3		3		3	2						2	3	
CO4	2		3		3	2						3	3	
CO5	3		3		2	2						3	3	

BM20904 **PATIENT AND DEVICE SAFETY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- introduce the safety standards of medical equipment
- study the parameters of safety and handling risk
- learn the effective remedies and acceptance
- access the clinical suitability to under the impact of the device on the environment
- understanding the medical equipment incorporating safety goals

UNIT I BASICS OF RELIABILITY AND CONCEPT OF FAILURE **9**

Reliability and Safety Testing - Reliability, Types of reliability, Reliability optimization & assurance, Reliability's effect on medical devices; The concept of failure - Causes of failure, Types of Failures in Medical devices; Safety testing - Device specific safety goals.

UNIT II SAFETY AND RISK MANAGEMENT **9**

Failure assessment and Documentation; Visual inspection - External & Internal visual inspection, Measurement, Safety parameters, Function test; Risk Management - Safety and risk management, Risk Deciding on acceptable risk, Factors important to medical device risk assessment; Tools for risk estimation - Liability, Manufacturer's and physician's responsibilities.

UNIT III ENVIRONMENTAL AND ECOLOGICAL SAFETY **9**

Devices Handling; Environmental and Ecological Safety - Safe medical devices, Handling and operation, Medical Application safety, Usability; Clinical assessment; Environmental safety - Interference with the environment, Environmental conditions, Impact on the environment, Ecological safety.

UNIT IV MECHANICAL AND ELECTRICAL SAFETY **9**

Mechanical and Electrical Safety - Safety Mechanics, Electrical Safety, Biological aspect; Limitation of Voltages - Macroshock and Microshock; Earth and Protection; Leakage currents; Magnetic fields and compatibility ; Basic assumptions in safety technology - Safety classes.

UNIT V MEDICAL DEVICES STANDARDS, REGULATIONS **9**

Medical Standards and Regulations; Device classification; Registration and listing; Declaration of conformance to a recognized standard - Investigational Device Exemptions (IDEs), Institutional Review Boards (IRBs), IDE format, Good laboratory practices (GLPs), Good manufacturing practices (GMPs); Human factors; Design control.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- classify the mechanical and electrical safety standards of medical equipment.
- apply device specific safety goals.
- interpret reasonable, acceptable and effective remedies.
- access the clinical suitability under the impact of the device on the environment.
- relate more reliable medical equipment incorporating safety goals.

TEXT BOOKS

1. Richard Fries, "Reliable Design of Medical Devices – Second Edition", CRC Press, Taylor & Francis Group,2006.
2. Norbert Leitgeb "Safety of Electro-medical Devices Law – Risks – Opportunities" Springer Verlog/Wein, 2010.

REFERENCES

1. Bertil Jacobson and Alan Murray, "Medical Devices Use and Safety", Elsevier Limited, 2007.
2. Gordon R Higson, "Medical Device Safety – The regulation of Medical Devices for Public Health and Safety", IOP Publishing Limited, Bristol and Philadelphia, 2002.
3. Shayne Cox Gad, "Safety Evaluation of Medical Devices" Second Edition, Marcel Dekker Inc., 2002.
4. Michael Wiklund, Jonathan Kendler, Alison Strochlic, "Usability Testing of Medical Devices", Second edition, CRC Press, Taylor and Francis Group, 2015.

CO/PO MAPPING :

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		Programmes Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3	3	3	3		2			3	3	
CO2	2		2	3	3		3	2	2			2	3	
CO3	3		3	2	2		2	2				2	3	
CO4	2		3	3	3		2		2			3	3	
CO5	3		3	3	2		2					3	3	