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

M.E. Medical Electronics

(Syllabus for Students Admitted during 2023-24 and onwards)

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

Avinashilingam Institute for Home Science and Higher Education for Women

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Department of Biomedical Instrumentation Engineering
M.E. Medical Electronics

Programme Outcomes:

1. Apply life science, engineering and mathematical concepts in modeling and design of biomedical systems of varying complexity.
2. Independently carry out research investigation and development work to solve practical problems.
3. Communicate efficiently to audience of multidisciplinary nature and to prepare technical documents and to present effectively
4. Demonstrate advanced knowledge of a selected area within Medical Electronics.
5. Model, design and realize biomedical devices, systems or processes.
6. Ability to understand ethical and social responsibilities.

Programme Specific Outcomes:

1: Achieve expertise in Medical equipment, Medical Imaging Systems, Biosignal Processing, Physiological Modeling and Simulation, Medical Image Processing and Research Methodology.
2: Apply emerging Information and Communication Technologies for innovation and identification of solutions in healthcare domain.

Scheme of Instruction & Examination

(For students admitted during 2023-2024 and onwards)

Part	*Course Code*	*Name of Course /Component*	*Hours of Instruction/week*		*Scheme of Examination*						
			T	*P*	*Duration of exam*	*CIA*		*CE*		*Total*	*Credit*
						T	P	T	P		
First Semester											
I	**Core Courses (CC)**										
	23MEMC01	Linear Algebra and Optimization Techniques	4	-	3	40	-	60	-	100	4
	23MEMC02	Diagnostic and Therapeutic Equipment	3	-	3	40	-	60	-	100	3
	23MEMC03	Biomedical Instrumentation Practicals	-	3	3	-	40	-	60	100	1.5
	23MEMC04	Biomedical Signal Processing Practicals	-	3	3	-	40	-	60	100	1.5
	23MEMC05	Research Methodology and IPR	3	-	3	40	-	60	-	100	3
	Program Electives (PE)										
	23MEME11/ 23MEME12/ 23MEME13	Program Elective-I	3	-	3	40	-	60	-	100	3
	23MEME21/ 23MEME22 23MEME23	Program Elective-II	3	-	3	40	-	60	-	100	3

II	**Non-Credit Mandatory Courses (NCMC)**										
	Audit Course (AC)										
	23MEMA11/ 23MEMA12/ 23MEMA13	Audit Course-I	3	-	2	100	-	-	-	100	Remark
	Extracurricular Course (ECC)										
		CSS/ Adult Education / Community Engagement and Social Responsibility	2	-	-	-	-	-	-	-	-

Program Elective I: 23MEME11 Biomedical Signal Processing / 23MEME12 Medical Imaging Systems and Radio Therapy/ 23MEME13 Human Anatomy and Physiology

Program Elective II: 23MEME21 Rehabilitation Engineering / 23MEME22 Biomechanics / 23MEME23 Human Assist Devices

Second Semester

Part	*Course Code*	*Name of Course /Component*	*Hours of Instruction/week*		*Scheme of Examination*						
			T	P	*Duration of exam*	*CIA*		*CE*		*Total*	*Credit*
						T	P	T	P		
I	**Core Courses (CC)**										
	23MEMC06	Physiological Modeling	3	-	3	40	-	60	-	100	3
	23MEMC07	Medical Image Processing	3	-	3	40	-	60	-	100	3
	23MEMC08	Medical Image Processing Practicals	-	3	3	-	40	-	60	100	1.5
	23MEMC09	Physiological Modeling Practicals	-	3	3	-	40	-	60	100	1.5
	23MEMC10	Mini Project with Seminar	-	2	-	-	100	-	-	100	1
	Program Electives (PE)										
	23MEME31/ 23MEME32/ 23MEME33	Program Elective-III	3	-	3	40	-	60	-	100	3
	23MEME41/ 23MEME42/ 23MEME43	Program Elective-IV	3	-	3	40	-	60	-	100	3
II	**Non-Credit Mandatory Courses (NCMC)**										
	Audit Course (AC)										
	23MEMA21/ 23MEMA22	Audit Course-II	3	-	2	100	-	-	-	100	Remark
	Extracurricular Course (ECC)										
	23MXCSS1/ 23MXAED1/ 23MXCSR1	CSS / Adult Education / Community Engagement and Social Responsibility	2	-	-	-	-	-	-	100	2
	Professional Certification Course (PCC)										
	23MEMPC1/ 23MEMPC2	Professional Certification Course	-	-	-	100	-	-	-	100	2

Internship/Training during Summer Vacation (1 month)

Program Elective III: 23MEME31 Pattern Recognition and its Applications/21MEME32 Medical Ethics and Standards / 23MEME33 AI and Machine Learning

Program Elective IV: 23MEME41 Telehealth Technology/21MEME42 Wearable Devices and Technologies / 23MEME43 Embedded Systems and Internet of Things for Medical Application

Third Semester

Part	Course Code	Name of Course /Component	Hours of Instruction/week		Scheme of Examination						
			T	P	Duration of exam	CIA		CE		Total	Credit
						T	P	T	P		
I	**Core Courses (CC)**										
	23MEMC11	Research Project - I	-	20	-	-	100	-	-	100	10
	Program Electives (PE)										
	23MEME51	Program Elective-V Title of MOOC (SWAYAM-NPTEL)*	3	-	-	-	-	100	-	100	3
	Open Electives (OE)										
	23MEDO01/ 23MEFO01/ 23MEEO01	Open Elective	3	-	3	40	-	60	-	100	3
II	23MEMC12	Internship/Training	-	-	-	-	100	-	-	100	2

***One MOOC (12 weeks duration) through SWAYAM - NPTEL with credit transfer of 3 credits as an alternative to one Program Elective Course, Program Elective - V in III Semester should be completed between 1st and 3rd semester. Title of the MOOC to be specified after enrolment.**

Open Electives: 23MEDO01 Principles and Techniques of Data Science/23MEFO01Industrial Safety and GMP in Food Industries /23MEEO01 Waste to Energy

Fourth Semester

Part	Course Code	Name of Course /Component	Hours of Instruction/week		Scheme of Examination						
			T	P	Duration of exam	CIA		CE		Total	Credit
						T	P	T	P		
I	**Core Course (CC)**										
	23MEMC13	Research Project - II	-	32	-	-	200	-	200	400	16
										Total	**73**
	23MEBMC1	**MOOC (Core/Non-core)**	-		-	-	-	-	-	-	2

One MOOC (8 weeks duration) with 2 credits from core/non-core to be completed between 1st and 3rd semester from SWAYAM – NPTEL (without credit transfer).

Requirements to earn the M.E. degree:

1. Total credits required to be earned in Part I & II components: 73
2. Minimum of 3 credits to be earned in MOOC (12 weeks duration) with credit transfer, as an alternative to one Program Elective in 3rd semester to be completed between 1st and 3rd semester from SWAYAM NPTEL.
3. Additionally one MOOC (8 weeks duration) with 2 credits from core/non-core to be completed between 1st and 3rd semester from SWAYAM – NPTEL (without credit transfer).
4. Successful completion of Part II Non-Credit Mandatory Courses (NCMC)

List of Program Electives (PE)

S. No	Course Code	Course Title
1.	23MEME11	Biomedical Signal Processing
2.	23MEME12	Medical Imaging Systems and Radio Therapy
3.	23MEME13	Human Anatomy and Physiology
4.	23MEME21	Rehabilitation Engineering
5.	23MEME22	Biomechanics
6.	23MEME23	Human Assist Devices
7.	23MEME31	Pattern Recognition and its Applications
8.	23MEME32	Medical Ethics and Standards
9.	23MEME33	AI and Machine Learning
10.	23MEME41	Telehealth Technology
11.	23MEME42	Wearable Devices and Technologies
12.	23MEME43	Embedded Systems and Internet of Things for Medical Application
13.	23MEME51	**MOOC (12 Weeks Course in SWAYAM- NPTEL)**

List of Audit Courses (Non-Credit Mandatory Course)

S. No	Course Code	Audit Course-I
1.	23MEMA11	English for Research Paper Writing
2.	23MEMA12	Disaster Management
3.	23MEMA13	Research and Publication Ethics

S. No	Course Code	Audit Course-II
1.	23MEMA21	Pedagogy Studies
2.	23MEMA22	Value Education

Open Elective (OE) offered by BMIE department

Part	Course Code	Course Title
I	23MEBO01	Quality Assurance and Safety in Hospitals

Professional Certification Course

Part	Course Code	Course Title
II	23MEMPC1	Digital Manufacturing for Medical Applications
	23MEMPC2	Unity Associate Certification – Game Developer

Other courses to be undergone by the student: MOOC courses 2 to 4 credits
Minimum 73 + 2 Credits to earn the degree

Linear Algebra and Optimization Techniques

Semester I **Hours of instruction / week: 4T**

23MEMC01 **No. of Credits: 4**

Objectives:

CLO1: To learn how to analyze and solve a linear system of equations

CLO2: To study optimization algorithms with single and multi-variables

Unit I Linear Equations **12**

Systems of Linear Equation, Row reduction and Echelon forms, Vector Equations, matrix equation AX = b-solution sets of Linear systems, Linear independence, Linear Transformations, Linear Models.

Unit II Orthogonality and Least Squares **12**

Inner product, Length and Orthogonality - Orthogonal sets - Orthogonal projections - Gram -Schmidt process - Least squares problem - Applications to Linear Models - Inner product spaces, Applications.

Unit III Introduction to Optimization **12**

Statement of Optimization problems - Classical optimization techniques - Single variable and multi variable optimization -Method of direct substitution

Unit IV Constrained Optimization **12**

Constraint variation - Lagrange multipliers, multivariable optimization with inequality constraints - Kuhn Tucker conditions.

Unit V Linear Programming **12**

Linear programming definition - Pivotal reduction of general system of equations - Simplex algorithms - Two phases simplex method - Revised simplex method - Duality in linear programming.

Total Hours: 60

Reference Books:

1. ***David C Lay, "Linear Algebra and its Applications***, 2nd Ed., Addison -Wesley, 2010.
2. ***Stephen. H. Friendberg, Arnod. J. Insel and Lawrence Spence, "Linear Algebra",*** Prentice Hall 4th Edition, 2010
3. ***Taha.H.A. "Operations Research"*** Prentice Hall, 2003.
4. ***Howard Anton, "Elementary Linear Algebra"*** John Wiley & sons, Inc. 1993
5. ***Nash, S G and Ariela Sofer, "Linear and Nonlinear Programming",*** McGraw Hill Book Com Inc, New York, 1996.

Course Outcomes:

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

- **CO1:** Improve skills in linear transformations and its applications
- **CO2:** Gain knowledge in applications of inner product spaces
- **CO3:** Apply various classical optimization techniques to solve unconstrained optimizing problems
- **CO4:** Formulate and solve problems under constrained optimization
- **CO5:** Apply simplex algorithm in solving linear programming problems

Diagnostic and Therapeutic Equipment

Semester I **Hours of Instruction/week: 3T**
23MEMC02 **No. of Credits: 3**

Objectives:

CLO1: To understand bio-potential recording, cardiac care and neurology equipment

CLO2: To gain knowledge on physiotherapy and diathermy equipment and recent trends in diagnostic and therapeutic equipment.

Unit I Bio-potential Recording **9**

ECG, EEG, EMG, PCG, EOG, lead system and recording methods, typical waveform, frequency spectrum, abnormal waveforms. Evoked response.

Unit II Cardiac Care Unit **9**

Pacemakers – Need, different types, electrode types and placement, batteries for pacemakers, Design. AC defibrillators, DC defibrillators - asynchronous and synchronous, Types of waveforms, electrode types and placement, precautions, Patient monitoring system. Case study

UNIT III Neurology Equipment **9**

Evoked response - Auditory, Visual and Somatosensory, Depth recording, Stereotaxy, EEG controlled Anesthetic monitor, Biofeedback equipment, Spinal reflex Measurement, Transcutaneous nerve stimulator. Case study.

Introduction to Brain Computer Interface-Need, types, Event Related Potential, P300, Mu rhythm, ERD/ERS, Rehabilitation applications of BCI - External device controllers, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation. Case study.

Unit IV Diathermy and Stimulator **9**

Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Galvanic, Faradic Stimulators, Interferential therapy, Leakage current, Micro and macro electric shock, GFI Units, Earthing Scheme, Electrical safety Analyzer.

Unit V Recent Trends **9**

Principles of Fiber optic cables, Endoscopy, Laparoscopy, principles of Lithotripsy, Principles of cryogenic Technique and application, Thermograph- Principle, sensors, system and applications. Bio telemetry- Need, Frequency selection, Modulation schemes, Single channel, Multichannel, Multipatient telemetry, Fluorescence imaging – FLIM and applications. Applications of IoT in Healthcare.

Total Hours: 45

Reference Books:

1. ***Webster J.G.,* "*Medical Instrumentation Application and Design*",** John Wiley and sons, New York 5th edition, 2020.
2. ***Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer,* "*Biomedical Instrumentation*",** Prentice Hall, New Delhi, 2000.
3. ***Joseph J Carr and John M Brown*, "*Introduction to Biomedical Equipment Technology*",** Pearson Education, 4th edition New Delhi, 2001.
4. ***Niebel, "Product Design",*** McGraw Hill, 1974.
5. ***John Denis Enderle, Joseph D. Bronzino, Susan M. Blanchard*, "*Introduction to Biomedical Engineering*",** 2nd edition, Academic Press, 2005.

Course Outcomes:

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

CO1: Record and analyze the various biosignals.

CO2: Describe the working of pacemakers and defibrillator and related circuits.

CO3: Illustrate the working of Neurological equipment and the application of these for BCI based rehabilitation application.

CO4: Understand the application of physiotherapy equipment and identify the electrical hazards in the hospital environment and make it shock free zone.

CO5: Discuss the recent trends in field of diagnostic and therapeutic equipment.

Biomedical Instrumentation Practicals

Semester I **Hours of Instruction/week: 3P**
23MEMC03 **No. of Credits: 1.5**

Objectives:

CLO1: To record and acquire the biosignal and measure the necessary parameters of physiological system

CLO2: To design preamplifier and Bioinstrumentation amplifier for acquiring biosignals.

List of Experiments

1. Design of preamplifier and bioinstrumentation amplifier for acquiring bio signals.
2. Recording ECG waveforms with 12 channel ECG machine.
3. Recording EEG waveforms with 32 channel EEG machine and significance of evoked potentials.
4. Recording heart sounds using Phonocardiograph
5. Recording of lung volumes and lung capacity using Spirometer.
6. Calculation of parameters like drip rate, volume infused using Drug infusion pump.
7. Plotting human auditory response using audiometer
8. Measurement of nerve conduction velocity using Electromyograph.
9. Measurement of blood velocity using Vascular Doppler.
10. Electrical safety testing of medical equipment.

Total Hours: 45

Course Outcomes:

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

CO1: Design, record and analyze the biosignals.
CO2: Compute the drip rate using drug infusion pump.
CO3: Identify the auditory level of humans.
CO4: Measure the blood velocity.
CO5: Test the electrical safety of medical equipment.

Biomedical Signal Processing Practicals

Semester I **Hours of Instruction/week: 3P**
23MEMC04 **No. of Credits: 1.5**

Objectives:

CLO1: To understand preprocessing of biosignals
CLO2: To gain knowledge on feature extraction and compression of biosignals

List of Experiments

1. Preprocessing of biosignals.
2. QRS detection using Pan-Tompkins algorithm in ECG signals.
3. Heart rate variability analysis in ECG signals.
4. Development of algorithm for ECG arrhythmia detection.
5. Band separation and spectrum of EEG signals.
6. Feature extraction in EMG signals.
7. Noise cancellation using Adaptive filters.
8. Denoising of biosignals using wavelets.
9. Biosignal compression
10. Biosignal analysis in virtual instrumentation platform.

Total Hours: 45

Course Outcomes:

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

CO1: Develop algorithms for preprocessing of biosignals.
CO2: Perform denoising and also analyze the spectral characteristics of biosignals.
CO3: Implement feature extraction.
CO4: Perform biosignal compression.
CO5: Analyze the biosignals in virtual instrumentation platform.

Research Methodology and IPR

Semester I **Hours of Instruction/week: 3T**
23MEMC05 **No. of Credits: 3**

Objectives:

CLO1: Problem formulation, analysis and solutions.

CLO2: Technical paper writing / presentation, Patent drafting and filing patents.

Unit I Research Problem Formulation **9**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

Unit II Literature Review **9**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

Unit III Technical Writing /Presentation **9**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

Unit IV Introduction to Intellectual Property Rights (IPR) **9**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Unit V Intellectual Property Rights (IPR) **9**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total Hours: 45

Reference Books:

1. ***Asimov, "Introduction to Design",*** Prentice Hall, 1962
2. ***Halbert, "Resisting Intellectual Property",*** Taylor & Francis Ltd ,2007
3. ***Mayall, "Industrial Design",*** McGraw Hill, 1992.
4. ***Niebel, "Product Design",*** McGraw Hill, 1974.
5. ***Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"*** 2010

Course Outcomes:

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

- **CO1:** Formulate research problem.
- **CO2:** Carry out research analysis.
- **CO3:** Follow research ethics.
- **CO4:** Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- **CO5:** Understand about IPR and filing patents in R & D.

Physiological Modeling

Semester II **Hours of Instruction/week: 3T**
23MEMC06 **No. of Credits: 3**

Objectives:
CLO1: To describe general principles for modeling and dynamic systems.
CLO2: To analyze models for cardio, pulmonary and respiration activities and perform simulation of physiological system.

Unit I Introduction **9**

Introduction to physiological system and mathematical modeling of physiological system, classification of model – gray box & black box, parametric & non parametric, lumped & distributed models, linear & non-linear, characteristics of models. Purpose of physiological modelling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy.

Unit II Dynamic Physiological System **9**

Dynamic systems and their control, modeling and block diagrams, Types of Eye movement, Eye movement system and Wetheimer's saccadic eye model. Robinson's Model, culomotor muscle model, Linear Reciprocal Innervations Oculomotor Model. Open & close loop systems instability, automatic aperture control.

Unit III Non Linear Models **9**

Nonparametric Modeling, Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modeling, Basic Parametric Model Forms and Estimation Procedures, Volterra Kernels of Nonlinear Differential Equations. Discrete, Time Volterra Kernels of NARMAX Model.

Unit IV Cardio, Pulmonary and Respiratory Modeling **9**

Cardiovascular system and pulmonary mechanics modeling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms. Respiratory mechanics & muscle mechanics. Voltage clamp experiment - Hodgkin and Huxley's model of action potential, model for strength-duration curve, model of the whole neuron.

Unit V Simulation of Physiological Systems **9**

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors - Introduction, receptor characteristics, transfer function models of receptors, receptor.

Total Hours: 45

Reference Botoks:

1. ***Michael C.K. Khoo, "Physiological Control System - Analysis, Simulation and Estimation"***, Prentice Hall of India, New Delhi, 2010.
2. ***David O. Cooney, "Bio-Medical Engineering Principles"*** Marcel Decker Pub. Co, 1976.
3. ***Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems",*** Wiley-IEEE Press, 2004.
4. ***Joseph D. Bronzino, "The Biomedical Engineering Hand Book",*** 3rd Edition, CRC Press, 2006.
5. ***John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit",*** Morgan & Claypool Publishers, 2010.
6. ***Douglas S. Rigg, "Control Theory and Physiological Feedback Mechanism"***, The William and Wilkins Co, Baltimore, 1970.
7. ***Richard Skalak and Shu Chien***, "***Hand Book of Biomedical Engineering"***, McGraw Hill and Co, New York, 1987.

Course Outcomes:

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

CO1: Understand the different types of physiological models.
CO2: Discuss the dynamic physiological systems.
CO3: Describe nonlinear models of physiological systems.
CO4: Analyze models for cardio, pulmonary and respiration mechanism.
CO5: Simulate the different types of physiological systems.

Medical Image Processing

Semester II **Hours of Instruction/week: 3T**
23MEMC07 **No. of Credits: 3**

Objectives:

CLO1: To familiarize with the fundamentals of medical image processing.

CLO2: To develop algorithms for analysis of medical images.

Unit I Image Fundamentals **9**

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two-dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – DFT, DCT, KLT, SVD.

Unit II Image Enhancement and Restoration **9**

Histogram equalization and specification techniques, 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- Analyze 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 Registration and Visualization **9**

Image Registration: Rigid body transformation – Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, Registration of Images from Different modalities, Evaluation of Registration Methods.

Image visualization: 2-D display methods, 3-D display methods, surface and volume based 3-D display methods – Surface Visualization and Volume visualization, 3-D Echocardiography, 3D+time Echocardiography, virtual reality based interactive visualization.

Total Hours: 45

Reference Books:

1. ***Atam P.Dhawan, "Medical Image Analysis***", Wiley Interscience Publication, NJ,USA 2003.
2. ***Wolfgang Birkfellner, "Applied Medical Image Processing",*** 2nd Edition CRC Press, 2016
3. ***John L.Semmalow, "Bio-signal and Biomedical Image Processing, MATLAB based applications"*** Marcel Dekker Inc., NewYork,2004
4. ***Kavyan Najarian and Robert Splerstor, "Biomedical Signal and Image processing",*** CRC–Taylor and Francis, NewYork,2006
5. ***R.C.Gonzalez and R.E.Woods, "Digital Image Processing",*** Second Edition, Pearson Education, 2002.

Course Outcomes:

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

CO1: Implement basic medical image processing algorithms.
CO2: Apply pre-processing techniques for medical images.
CO3: Describe medical image representation techniques.
CO4: Analyze image segmentation, feature extraction and image classification.
CO5: Illustrate image registration and visualization techniques.

Medical Image Processing Practicals

Semester II **Hours of Instruction/week: 3P**
23MEMC08 **No. of Credits: 1.5**

Objectives:

CLO1: To apply image processing techniques using MATLAB.
CLO2: To develop algorithms for post processing of medical images.

List of Experiments

1. Preprocessing of medical images.
2. Filtering of medical images.
3. Edge detection using Python.
4. Segmentation of ROI in medical images.
5. Medical image compression techniques.
6. Analysis of medical images using DWT.
7. Medical image registration.
8. Feature extraction in medical images.
9. Statistical analysis of features.
10. Neural network based classification.

Total Hours: 45

Course Outcomes:

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

CO1: Develop algorithm for preprocessing of medical images.
CO2: Extract the region of interest from medical images.
CO3: Perform image compression.
CO4: Develop an image registration algorithm for medical images
CO5: Design algorithms for feature extraction and classification.

Physiological Modeling Practicals

Semester II **Hours of Instruction/week: 3P**
23MEMC09 **No. of Credits: 1.5**

Objectives:

CLO1: To develop models for physiological systems.
CLO2: To analyze muscle stretch reflex and cardiovascular variability models.

LIST OF EXPERIMENTS

1. Design Lumped and Distributed SIMULINK model for simple lung mechanism.
2. Design a SIMULINK model for steady-state analysis of muscle stretch reflex.
3. Design a SIMULINK model for steady-state respiratory control.
4. Design a SIMULINK model of neuromuscular reflex models.
5. Design a SIMULINK model to compute frequency response of linearized lung mechanics model.
6. Design a SIMULINK model to compute frequency response of glucose-insulin regulation (Stolwijk and Hardy model).
7. Design a SIMULINK model for respiratory sinus arrhythmia (Saul model).
8. Design a SIMULINK model of simplified and linearized version of Hodgkin-Huxley model.
9. Design a SIMULINK model for cardiovascular variability. (stroke volume constant)
10. Design a SIMULINK model for cardiovascular variability. (stroke volume variable)

Total Hours: 45

Course Outcomes:

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

CO1: Develop a model for lung mechanism using SIMULINK.
CO2: Analyze muscle stretch reflex model.
CO3: Determine the frequency response of glucose-insulin regulation.
CO4: Design a model for respiratory control system.
CO5: Analyze cardiovascular variability model.

Mini Project with Seminar

Semester II **Hours of Instruction/week: 2P**
23MEMC10 **No. of Credits: 1**

Objective:

CLO: To expose the student to new concepts related to Medical Electronics and to get familiarized with the modern tools.

Research Project - I

Semester III **Hours of Instruction/week: 20**
23MEMC11 **No. of Credits: 10**

Objective:

CLO: To make the students to undertake project in Industry/In-house as Project phase- I

Internship/Training

Semester III **Hours of Instruction/week: -**
23MEMC12 **No. of Credits: 2**

Objective:

CLO: To expose the students to actual working environment (Industry / Hospital) and enhance their knowledge and skill from what they have learnt.

Research Project - II

Semester IV **Hours of Instruction/week: 32**
23MEMC13 **No. of Credits: 16**

Objective:

CLO: To make the students to continue Project phase – I idea/Implementation of new ideas as Project phase – II

Program Elective-I
Biomedical Signal Processing

Semester I **Hours of Instruction/week: 3T**
23MEME11 **No. of Credits: 3**

Objectives:

CLO1: To understand the concepts of biosignals and time series analysis.

CLO2: To acquire knowledge about filtering techniques, biosignal classification and recognition.

Unit I Signal Systems and Spectrum **9**

Characteristics of some dynamic biomedical signals, Noises, random, structured and physiological noises. Filters, IIR and FIR filters. Spectrum**,** power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

Unit II Time Series Analysis and Spectral Estimation **9**

Time series analysis**,** linear prediction models, process order estimation, lattice representation, non, stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model-based ECG simulator. Spectral estimation, Blackman Tukey method, periodogram, and model-based estimation. Application in Heart rate variability, PCG signals,

Unit III Adaptive Filtering and Wavelet Detection **9**

Filtering**,** LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG**,** structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

Unit IV Bio-Signal Classification and Recognition **9**

Signal classification and recognition, Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network-based classification. Application in Normal versus Ectopic ECG beats.

Unit V Times Frequency and Multivariate Analysis **9**

Time frequency representation, spectrogram, Wigner distribution, Time, scale representation, scalogram, wavelet analysis**,** Data reduction techniques, ECG data compression, ECG characterization, Feature extraction, Wavelet packets, Multivariate component analysis, PCA, ICA

Total Hours: 45

Reference books:

1. ***Arnon Cohen*, "*Biomedical Signal Processing*",** Vol. I and Vol. II, CRC Press Inc., Boca Raton, Florida 2004.
2. ***Rangaraj M. Rangayyan, "Biomedical Signal Analysis, A case study approach",*** Wiley, Interscience / IEEE Press, 2002
3. ***Willis J. Tompkins*, "*Biomedical Digital Signal Processing*",** Prentice Hall of India, New Delhi, 2003.
4. ***Raghuveer M. Rao and Ajiths Bopardikar, "Wavelets transform, Introduction to theory and its applications",*** Pearson Education, India 2000.
5. ***D.C.Reddy*, "*Biomedical Signal Processing , Principles and Techniques*",** TMH, New Delhi,2005

Course Outcomes:

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

- **CO1:** Analyze the different types of signals and systems.
- **CO2:** Analyze signals in time series domain and estimate the spectrum.
- **CO3:** Demonstrate the significance of wavelet detection applied in biosignal processing.
- **CO4:** Perform classification of biosignals.
- **CO5:** Extract the features using multivariate component analysis.

Medical Imaging Systems and Radio Therapy

Semester I **Hours of Instruction/week: 3T**
23MEME12 **No. of Credits: 3**

Objectives:

CLO1: To study the production of X-rays and its application in medical imaging.

CLO2: To understand the basic principles of ultrasound, MRI and thermal imaging and discuss the radiation therapy.

Unit I X – Rays and Computed Tomography **9**

Principle and production of X – Rays, Selection of anodes, heel pattern, Scattered Radiation, Porter-Bucky systems, Digital Radiography, principles of Angiography and Fluoroscopic Techniques, Image Intensifiers, digital subtraction angiography, mammography, dental X- ray units. Computerised Axial Tomography, Principle, Detectors, image reconstruction, Spiral CT, 3DImaging.

Unit II Emission Imaging **9**

Alpha, Beta, Gamma Emission, different types of Radiation Detectors, G.M. & Proportional Counters, Pulse Height Analyzers, Isotopic, Scanners, Principle of PET and SPECT, PET/CT.

Unit III Magnetic Resonance Imaging **9**

Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI instrumentation, Magnets, gradient coils, Imaging Different Sections of the Body, Tissue Characterization, MR Spectroscopy, Functional MRI.

Unit IV Ultrasound Imaging and Thermography **9**

Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes-A, B & M, Principles and theory of image generation. Thermography-Principle, detectors and applications.

Unit V Therapy Using X – Rays and Isotopes **9**

Direct and Indirect effects of high energy radiation, Units for radiation Exposure, Depth Dose curves, Linear Accelerator Betatron, Cobalt and Cesium Therapy, Computation of Absorbed Dose Level, Automatic Treatment Planning, ICRP regulation, Hazardous Effects of Radiation, Radiation measuring units, Allowed Levels, Protection Methods.

Total Hours: 45

Reference Books:

1. ***Isaac Bankman, I. N. Bankman*, "*Handbook of Medical Imaging: Processing and Analysis*",** Biomedical Engineering Series, Academic Press,2000
2. ***Donald Graham, Paul Cloke, Martin Vosper,* "*Principles of Radiological physics*"**, Churchill Livingston, 6 th Edition, 2011.
3. ***K.Krish Shung, B. Smith, Benjamin Tsui,* "*Principles of Medical Imaging*"**, Academic Press Inc., London 2006.
4. ***Jacob Beutel (editor), M. Sonka (editor),* "*Handbook of Medical Imaging*",** Vol.2, SPIE Press 2000
5. ***Avinash C.Kak, Malcolm Shaney*, "*Principles of Computerized Tomographic Imaging*",** IEEE Press, New York, 2003.

Course Outcomes:

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

- **CO1:** Discuss the principle and working of various radiography and tomography concept and image reconstruction techniques.
- **CO2:** Explain the concept of nuclear imaging techniques and radiation detectors.
- **CO3:** Describe the basic principle and working of Magnetic resonance imaging technique.
- **CO4:** Describe the basic principle involved in Ultrasound Imaging technique and Thermography.
- **CO5:** Discuss the effects of radiation, radiation safety and the principle of Radio therapy techniques.

Human Anatomy and Physiology

Semester I **Hours of instruction / week: 3T**
23MEME13 **No. of Credits: 3**

Objectives:

CLO1: To learn the basic concepts of cell structure and its functioning.
CLO2: To familiarize with the structure of human body and it's functioning.

Unit I Introduction to Human Body **9**

Organization of human body, tissue and cavities, Anatomical planes, positions and sections. Cell Structure and organelles structure, Functions of Each components in the cell. Cell membrane Transport, Resting membrane potential and ionic basis of potentials, Recording of Action potentials, Homeostasis.

Unit II Musculoskeletal System **9**

Skeletal System: Bones, types and functions - Axial and Appendicular Skeleton. Joints: Definition, Types and functions. Cartilage: An overview - types and functions. Muscular System: Types of Muscle - Skeletal Muscle structure - Action potential and functions - Skin and Appendages.

Unit III Respiratory, Gastrointestinal and Urinary System **9**

GI Tract: Organization of GI tract – Mouth, Pharynx, Esophagus, Stomach, Small Intestine and Large Intestine - Accessory Organs: Salivary glands, Liver, Pancreas, Gall bladder, Teeth and Tongue. Respiratory System: The Nose, Pharynx, Larynx, Trachea, Primary Bronchi, Lungs – Mechanism of Breathing – Respiratory Volumes and Measurements.

Urinary System: Structure of Kidney, Nephron, Ureter and Urinary bladder. Urine formation and Micturition reflex- Homeostasis and blood pressure regulation by urinary system.

Unit IV Cardiovascular, Lymphatic and Endocrine System **9**

Cardiovascular System: Blood vessel, Types and internal structure - Cardiac Muscle: Structure and Action potential – Structure and Components of Heart - Conducting System of Heart – Heart Sounds – Blood Pressure. Lymphatic System: Lymphatic vessel – Lymph fluid – Lymph nodes - Endocrine System: Hormones – Anterior and Posterior Pituitary Gland Hormones.

Unit V Nervous System and Special Senses **9**

Organization of Nervous system: Structure, Types and Properties of Neurons - Neuroglial Cells – Central Nervous System and Peripheral Nervous System organization – Brain, Lobes and Cortical Areas – Spinal cord – Spinal tract and Spinal nerve formation - Autonomic Nervous System: Divisions and control on each system - Reflex Mechanism. Special Senses: Structure of Eye and Ear

Total Hours: 45

Reference books:

1. ***Guyton*, "*Text book of Medical Physiology*",** WB Saunders company, Philadelphia, 10th edition, 2002
2. ***Elaine.N. Marieb, "Essential of Human Anatomy and Physiology",*** Eight edition, Pearson Education New Delhi, 2007.
3. ***Cyrul A Keele** and **Eric Neil Samson's* "*Wrights Applied Physiology*"** Oxford University Press, New Delhi, 2005
4. ***Ranganathan T S*, "*Text Book of Human Anatomy*",** S. Chand and company, New Delhi, 2009

Course Outcomes:

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

CO1: Recall the organelles and physiological mechanisms involved in cell.

CO2: Understand about interconnection of musculoskeletal system.

CO3: Discuss the organisation and functions of gastrointestinal, respiratory and urinary system.

CO4: Illustrate the cardiovascular system and endocrine system.

CO5: Describe about the functions and structure of nervous system and special senses.

Program Elective-II

Rehabilitation Engineering

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

23MEME21 **No. of Credits: 3**

Objectives:

CLO1: To understand the various rehabilitation aids and its working.

CLO2: To acquire knowledge about rehabilitation medicine.

Unit I Introduction to Rehabilitation **9**

Definition: Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team members and their function. Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation. Rehabilitation care, Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

Unit II Prosthetic and Orthotic Devices **9**

Types of body powered and externally powered limb prosthetics, Lower limb, Upper limb orthotics, materials for prosthetic and orthotic devices, mobility aids, wheel chair. Functional Electrical Stimulation – restoration of upper limb and lower limb functions. Hybrid Assistive Systems (HAS). Gait analysis, Assessment of mobility rehabilitation, Bionic arm

Unit III Auditory and Speech Assist Devices **9**

Types of deafness, hearing aids, application of DSP in hearing aids, vestibular implants, Voice synthesizer, speech trainer.

Unit IV Visual Aids **9**

Ultrasonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers.

Unit V Rehabilitation Medicine and Advocacy **9**

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.

Total Hours: 45

Reference Books:

1. ***Rory A.Cooper, Hisaichi, Ohnabe, Douglas A Hobson*****, "*****An introduction to Rehabilitation Engineering*****",** CRC Press, 2006.
2. ***Webster J.G,* "*****Minimally Invasive Medical Technology*****",** CRC Press, 2001.
3. ***Joel A.Delisa, Bruce M Grans, Nicholas E Walsh*****, "*****Physical Medicine and Rehabilitation*****",** Lippincott Williams and Wilkins, 2005.

Course Outcomes:

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

- **CO1:** Understand various terms related to rehabilitation engineering and their importance.
- **CO2:** Identify prosthetic and orthotic devices for restoration of limb function
- **CO3:** Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society
- **CO4:** Discuss devices for visually challenged
- **CO5:** Analyze recent trends and different aspects on rehabilitation

Biomechanics

Semester I **Hours of Instruction/week: 3T**
23MEME22 **No. of Credits: 3**

Objectives:

CLO1: To understand the mechanisms of biological systems.

CLO2: To explore knowledge on biomechanical aspect of accident investigation.

Unit I Introduction **9**

Introduction to bio-mechanics, relation between mechanics and Medicine, Newton's laws, bio-fluid mechanics, soft tissue mechanics, stress, strain, shear rate, viscosity, visco-elasticity, non-Newtonian viscosity, mechanical properties of soft biological tissues.

Unit II Mechanics of Circulation **9**

Flow properties of blood, effect of shear rate, Hematocrit, temperature and protein Content of blood, rheology of blood and micro vessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves.

Unit III Mechanics Applied to Orthopedics **9**

Orthopedic biomechanics, mechanical properties of bones, stress induced bone growth, kinematics and kinetics of joints, lubrication of joints and analysis of force in orthopedic implants.

Unit IV Mechanism of Biological Systems **9**

Skeletal muscles servo mechanism, Cardio vascular control mechanism, respiratory control mechanism, Finite element analysis in Biomechanics - case study.

Unit V Biomechanical Aspect of Accident Investigation **9**

Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury**,** Accident reconstruction, Analysis of impact, skid analysis, Damage analysis.

Total Hours: 45

Reference Books:

1. ***Y.C.Fung*, "*Biomechanics: Mechanical Properties in Living Tissues*",** Springer Verlag, New York, 2007.
2. ***D.Dawson and Right*, "*Introduction to Bio-mechanics of Joints and Joint Replacement*",** Mechanical Engineering publications Ltd. 2011.
3. ***Jacob Cline*, "*Hand book of Biomedical Engineering*",** Academic Press, Sandiego, 2000.
4. ***Susan J.Hall*, "*Basics of Bio Mechanics*",** 4th Edition, McGraw Hill Publishing Co, 2002.

Course Outcomes:

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

CO1: Understand the applications of mechanics in medicine.

CO2: Describe the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments.

CO3: Evaluate the force in implants.

CO4: Illustrate the mechanics of various biological systems.

CO5: Analyze different injuries from accident investigation.

Human Assist Devices

Semester I **Hours of Instruction/week: 3T**
23MEME23 **No. of Credits: 3**

Objectives:

CLO1: To acquire knowledge on artificial heart and cardiac assist devices.

CLO2: To gain knowledge on artificial kidney, principle of prosthetic and orthotic devices, respiratory devices and hearing aids.

Unit I Heart Lung Machine and Artificial Heart **9**

Conditions to be satisfied by the Heart Lung 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 Venous Arterial Pumping, Prosthetic Cardio 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 hemo-dialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

Unit IV Prosthetic and Orthotic Devices **9**

Hand and Arm Replacement**,** Different Types of Models Externally Powered Limb Prosthesis Feedback in Orthotic System, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices

Unit V Respiratory and Hearing Aids **9**

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, CPAP machine.

Total Hours: 45

Reference Books:

1. ***Gray E Wnek, Gray L Browlin*****, "*****Encyclopedia of Biomaterials and Biomedical Engineering*****",** Marcel Dekker Inc. New York, 2004.
2. ***John. G. Webster,* "*****Bioinstrumentation*****"**, John Wiley & Sons (Asia) Pvt. Ltd**,** 2004.

Course Outcomes:

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

- **CO1:** Discuss the importance of heart lung machine and artificial heart.
- **CO2:** Describe the functioning of cardiac assist devices.
- **CO3:** Understand the various types of artificial kidney and its functions.
- **CO4:** Identify the prosthetic and orthotic devices
- **CO5:** Illustrate the use of respiratory assist devices and hearing aids

Program Elective-III
Pattern Recognition and its Applications

Semester II **Hours of Instruction/week: 3T**
23MEME31 **No. of Credits: 3**

Objectives:

CLO1: To understand the fundamentals of pattern recognition and impart knowledge on various clustering techniques

CLO2: To choose an appropriate feature selection and pattern classification algorithm for a pattern recognition problem

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 Support Vector Machines **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, cell cytology classification.

Total Hours: 45

References books:

1. ***Andrew Webb, "Statistical Pattern Recognition",*** Arnold publishers, London, 2002.
2. ***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. ***Robert J. Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches",*** John Wiley & Sons Inc., New York, 1992.
7. ***S.Theodoridis and K.Koutroumbas, "Pattern Recognition",*** 4th Edition, Academic Press, 2008.

Course Outcomes:

Upon Completion of the course, the students will be able to:

CO1: Perform classification using Baye's approach.
CO2: Implement clustering algorithms for classification
CO3: Perform feature extraction and feature reduction
CO4: Apply HMM and SVM for real time applications.
CO5: Apply pattern recognition techniques for bio-signal and medical image applications

Medical Ethics and Standards

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

23MEME32 **No. of Credits:3**

Objectives:

CLO1: To understand the ethics and moral principles followed in Hospitals.

CLO2: To acquire knowledge about hospital and medical equipment safety standards.

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 and Moral Principles **9**

Theories, Deontology & Utilitarianism, Causist theory, Virtue theory, The Right Theory. Principles, Non-Malficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine

Unit III Hospital Accreditation Standards **9**

Accreditation, JCI Accreditation and its Policies. Patient centered standards, Healthcare Organization management standards, Indian Perspective.

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 Medical Equipment Safety Standards **9**

General requirements for basic safety and essential performance of medical equipment 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

Total Hours: 45

Reference Books:

1. ***"Biomedical Ethics: A Canadian Focus. Johnna Fisher*** (ed.), Oxford University Press Canada, 20012.
2. ***Ben Mepham "Bioethics, An Introduction for the biosciences",*** 2nd edition 2008, Oxford.
3. ***Domiel A Vallero "Biomedical Ethics for Engineers"***, ElsevierPub.1st edition, 2007.
4. ***"Joint Commission Accreditation Standards for Hospitals",*** 2nd edition, 2003.

5. ***Nils Hoppe and Jose Miola, "Medical law and Medical Ethics"***, Cambridge University Press, 2014.
6. ***Robert M Veatch "Basics of Bioethics",*** Second Edition. Prentice, Hall, Inc 2003

Course Outcomes:

Upon Completion of the course, the students will be able to:

CO1: Describe the social responsibility in healthcare systems.
CO2: Discuss the Bioethics and engineers role.
CO3: Apply legal and professional guidelines for the hospital accreditation.
CO4: Interpret hospital safety and standards.
CO5: Comprehend the medical equipment safety standards and medical device maintenance.

AI and Machine Learning

Semester II **Hours of Instruction/week: 3T**
23MEME33 **No. of Credits: 3**

Objectives:

CLO1: To acquire knowledge on machine learning and an idea of fuzzy sets, fuzzy logic.

CLO2: To familiarize with genetic algorithms for seeking global optimum in self-learning situations.

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 System **9**

Fuzzy Logic System: Basic of fuzzy logic theory, crisp and fuzzy sets, Basic set operation like union, interaction, 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.

Total Hours: 45

Reference Books:

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; 1st 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 Learning",*** Pearson Education, 2006
8. ***Michael Nielsen, "Neural Networks and Deep Learning"***, March 2017.

Course Outcomes:

Upon Completion of the course, the students will be able to:

- **CO1:** Identify and describe machine learning techniques and their roles in building intelligent system.
- **CO2:** Design neural networks for pattern classification and regression problems.
- **CO3:** Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- **CO4:** Apply genetic algorithms to optimization problems.
- **CO5:** Apply Deep learning concept for biomedical signal analysis and Medical image analysis.

Telehealth Technology

Semester II **Hours of Instruction/week: 3T**
23MEME41 **No. of Credits: 3**

Objectives:

CLO1: To learn the key principles of telemedicine and understand telemedical technology.

CLO2: To familiarize with telemedical standards, mobile telemedicine and applications of telemedicine.

Unit I Telemedicine and Health **9**

History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, 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, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

Unit IV Mobile Telemedicine **9**

Teleradiology: Definition, Basic parts of tele-radiology system: Image Acquisition system Display system, Telepathology, 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**

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.

Total Hours: 45

Reference Books:

1. ***Khandpur. R.S.,*** "***Telemedicine Technology and Applications***", PHI India, 2017
2. ***Norris, A.C. "Essentials of Telemedicine and Telecare",*** Wiley, 2013
3. ***Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine. Royal Society of Medicine***" Press Ltd, Taylor & Francis 2007
4. ***Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics***, Volume 54, 2002.
5. ***Mohan Bansal, "Medical Informatics***", Tata McGraw-Hill, 2004.

Course Outcomes:

Upon Completion of the course, the students will be able to:

CO1: Describe the key principles for telemedicine.
CO2: Discuss the communication infrastructure required for telemedicine.
CO3: Understand various telemedicine standards.
CO4: Develop the m-Health platforms for telemedical applications.
CO5: Illustrate the telemedical applications.

Wearable Devices and Technologies

Semester II **Hours of Instruction/week: 3T**
23MEME42 **No. of Credits: 3**

Objectives:

CLO1: To understand the basic principles of wearable physiological monitoring systems and smart sensors.

CLO2: To be familiar with the technologies used for wearable device and data processing.

Unit I Introduction Wearable Systems **9**

What is Wearable Systems, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Recent developments , Global and Indian Scenario, Types of Wearable Systems, Components of wearable Systems, Physiological Parameters commonly monitored in wearable applications, Smart textiles, & textiles sensors, Wearable Systems for Disaster management, Home Health care, athletes, Sleep Apnea Monitoring.

Unit II Vital Parameters and Smart Sensors **9**

Vital parameters monitored and their significances, Bio-potential signal recordings (ECG, EEG, EMG), Dry Electrodes design and fabrication methods, Smart Sensors , textile electrodes, polymer electrodes, non-contact electrodes, MEMS and Nano Electrode Arrays, Cuff-less Blood Pressure Measurement, PPG, Galvanic Skin Response (GSR), Body Temperature Measurements, Activity Monitoring for Energy Expenditure, Respiratory parameters.

Unit III Technologies used for a Wearable Device **9**

Basic principles of different sensors, micro-motors and communication channels used in wearable devices These include accelerometers, optical sensor, GPS, various input methods, Power Requirements, Wearable Systems Packaging, Batteries and charging, Wireless Communication Technologies and Protocols, Receiver Systems (Redrafting may be needed)

Unit IV Wireless Body Area Networks **9**

Wireless Body Area Networks, Introduction, Personal Area Networks (PAN), Application in Vital Physiological Parameter monitoring, Design of Sensor & Sink Nodes, Architecture, Communication & Routing Protocols, Security, Power and Energy Harvesting, Mobile Applications based devices.

Unit V Data Processing and Validation **9**

Classification Algorithms, Data Mining and Data Fusion, Signal Processing Algorithms in wearable Applications, Issues of wearable physiological monitoring systems, Statistical Validation of Parameters, Certifications of Medical Devices and Patenting.

Total Hours: 45

Reference Books:

1. ***Annalisa Bonfiglo, Danilo De Rossi, "Wearable Monitoring Systems",*** Springer, 2011.
2. Edward Sazonov, Micheal R Neuman, ***"Wearable Sensors: Fundamentals, Implementation and Applications",*** Elsevier, 2014.
3. ***Guang Zhong Yang, "Body Sensor Networks",*** Springer,2005
4. ***Kate Hartman, Make: "Wearable Electronics: Design, Prototype and wear your own interactive garments",*** MakerMedia,2009
5. ***W. Barfield and T. Caudell, eds., "Fundamentals of Wearable Computers and Augmented Reality, Mahwah"***, NJ: Laurence Erlbaum Associates, 2001.
6. ***S. Bouwstra, W. Chen, L. Feijs, S. Bambang Oetomo, "Smart Jacket Design for Neonatal Monitoring with Wearable Sensors",*** Proceedings of Body Sensor Networks (BSN), 2009, Berkeley, USA, pp. 162-167.

Course Outcomes:

Upon Completion of the course, the students will be able to:

CO1: Understand the basics of wearable systems.
CO2: Discuss the significance of vital parameters and smart sensors.
CO3: Describe the technologies used for wearable device.
CO4: Demonstrate the concepts of body area networks.
CO5: Explain the algorithms for data processing and validation

.

Embedded Systems and Internet of Things for Medical Application

Semester II **Hours of Instruction/week: 3T**
23MEME43 **No. of Credits: 3**

Objectives:

CLO1: To understand the basic concepts of ARM processors and design analysis

CLO2: To acquire knowledge on process, operating system of ARM processors and Hardware accelerates.

Unit I Hardware and Software of Arm Processor **9**

ARM processor fundamentals, architecture, Instruction set, Memory system, Exception/ Interrupt handling. Cortex-M Processors, Embedded Software Development-Introduction to C language and C preprocessor.

Unit II Data Acquisition Systems **9**

Analog signals: amplitude, bandwidth; Analog multiplexing, Anti-aliasing filters, Analog to Digital converter, Sensor interfacing, sampling theorem, Digital filters, UART to USB converters, Bluetooth, Zigbee and Wi-fi Communication protocols.

Unit III Sensor Interfacing with Microcontroller Boards **9**

Basics of hardware design, functions of passive components-sensors and actuators, Introduction to Arduino Due; Arduino integrated development environment and programming.

Unit IV IoT: An Introduction **9**

Networked Embedded System types and overview, Introduction to IOT , Application of IOT in health-care - Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness.

Unit V Embedded Web-Server & IoT Cloud Services Application & Case Study **9**

Embedded web server: Basic introduction and its application in IOT.

Case Study1: Wireless Patient Monitor system

Case Study2: Wearable Fitness & Activity Monitor

Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration, Design of single channel and multi-channel ECG and EMG amplifier systems incorporating analog, digital communication

Total Hours: 45

Reference Books:

1. ***Andrew N Sloss, Dominic Symes and Chris Wright, "ARM system developer 's guide, Designing and Optimizing System Software",*** Morgan Kaufmann publishers-2004.
2. ***David E. Simon, "An Embedded Software Primer",*** Pearson Education-2007.
3. ***K.V.K.K. Prasad, "Embedded Real-Time Systems: Concepts, Design &Programming",*** Dream Tech Press-2005.

4. ***Tim Wilmshurst, "An Introduction to the Design of Small-Scale Embedded Systems",*** Pal grave Publisher, 2004.
5. ***Wayne Wolf, "Computers as Components, Principles of Embedded Computer System Design",*** Morgan Kaufmann Publisher, 2006.

Course Outcomes:

Upon Completion of the course, the students will be able to:

CO1: Develop hardware and software for ARM processor, Understand ARM processor and Building Blocks of Embedded Systems.
CO2: Understand the data acquisition system.
CO3: Acquire Knowledge on sensor interfacing with Arduino.
CO4: Discuss about principles of IoT.
CO5: Build various applications in healthcare using IoT based approach and substantiate the same with appropriate.

Community and Social Service (CSS)

Semester I **Hours of Instruction/Week: 2**
23MXCSS1
Objectives:

CLO1: To create awareness on needs and problems of the community with social awareness and a caring attitude for needy people

CLO2: To develop skills in organizing women into groups for collective action

Unit I Profile of Women in India **6**

Profile of women in terms of literacy, work participation, health, reproductive health and nutrition and social and political participation. Survey to find out the literacy rate in different areas.

Unit II Government Programmes for the upliftment of Women **6**

Education, Employment and Health

Unit III Organizational support for Women **6**

Self-help Groups, a strategy for Entrepreneurship among women. Role of NGOs for upliftment of women, organizing women into groups.

Unit IV Women and Political Participation **6**

Need for political empowerment of women, 73rd amendment, 1/3rd reservation of women in Panchayat and local bodies performances, problems and prospects of elected women. Study the participation of women in local bodies

Unit V Students involvement in community Social Services **6**

Data base on women – literacy, employment, issues related to work participation, marital problems and disability. Awareness generation programmes – child labour, violence against women, blood donation and legal provisions safeguarding women. Activities oriented: adult literacy and subject related activities

Total hours: 30

Reference Book:

1. ***Department of Home Science Extension, 2006, approaches to women and Development, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore.***

Course Outcomes:

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

- **CO1:** Discuss the attributes of being morally and intellectually responsive with social awareness and a caring attitude for needy people
- **CO2:** Explain how to serve the community by applying their professional knowledge and skills
- **CO3:** Organize various types of community service activities and awareness programmes.
- **CO4:** Describe the participation of women in local bodies
- **CO5:** Develop a right attitude of life, good interpersonal and communication skills and a sense of social awareness

Open Elective

Quality Assurance and Safety in Hospitals

Semester III **Hours of Instruction/week: 3T**
23MEBO01 **No. of Credits: 3**

Objectives:

CLO1: To acquire knowledge on quality assurance and safety in hospitals.
CLO2: To familiarize with the electrical and fire safety and quality health care.

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 Healthcare **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 and Fire Safety **9**

Sources of shocks, macro and 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 and Independent, Measuring Quality care, Evaluation of hospital services, six sigma way, Quality Assurance in Hospitals SOP, Patient Orientation for Total Patient Satisfaction. 5S techniques.

Total hours: 45

Reference Books:

1. ***B. M. Sakharkar, "Principles of Hospital administration and Planning",*** JAYPEE Brothers, Medical Publishers (P) Ltd.
2. ***Joseph F Dyro, "Clinical Engineering Handbook"*** Elsevier Publishers, 2004.
3. ***Karen Parsley, Karen Parsley Philomena Corrigan, "Quality improvement in Healthcare"***, 2nd edition, Nelson Thrones Pub,2002
4. ***K.Shridhara Bhat, "Quality Management"***, Himalaya Publishing House.

5. ***Webster J.G and Albert M.Cook, "Clinical Engineering, Principles & Practices"***, Prentice Hall Inc., Engle wood Cliffs, New Jersey, 1979.
6. ***Sharon Myers, "Patient Safety & Hospital Accreditation",*** A Model for Ensuring Success, Springer Publishers, 2012

Course Outcomes:

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

CO1: Summarize the concepts of quality management in health care organization.
CO2: Describe the regulatory requirement for healthcare.
CO3: Discuss safety aspects in hospitals.
CO4: Illustrate the electrical and fire safety in hospitals.
CO5: Identify a suitable method for the evaluation of hospital services.

Audit Course-I
English for Research Paper Writing
(Non-credit Mandatory Course)

Semester I **Hours of Instruction/week: 3T**
23MEMA11

Objective:

CLO1: To familiarize with language for a research paper and research ethics

CLO2: To educate the students to write an effective research paper

Unit I Language of a Research Paper and Ethics **9**

Scientific Papers - Definition, Key characteristics - Clarity, Understanding the signals, Language of a scientific paper, Research ethics, rights and permissions- originality and authorship, avoiding ambiguity and vagueness

Unit II Title Writing **9**

Components of a research paper- Importance and requirements while choosing a title. Importance of Syntax in title, Title as a label, matching title to relevance of study

Unit III Abstract and Content Writing **9**

Preparation of abstract. Types of abstracts, Economy of words, Introduction, Reasons for rules, Citations and abbreviations; Writing of Materials and Methods- Purpose, Materials, online resources, Methods, Measurements and analysis, Need for -Tabular materials, References and correct form and Grammar, Abbreviations and Jargons

Unit IV Result Writing **9**

Results and discussion: Results - Contents, Striving for clarity, Handling of numbers, Discussion- components, Factual relationship, significance of the paper, Defining scientific truth. Tables and Illustrations- Graphs, Photographs-when, where and how to use. Importance of Conclusion

Unit V Journal Writing **9**

Citing of references - Rules to follow, reference styles and systems, Titles and inclusive pages, Journal abbreviations. Journal publication - Factors to be considered in choosing the journal, Cover letter to journals for publishing the manuscript. Use and misuse of English in manuscript, Ten commandments of good writing.

Total hours: 45

Reference Books:

1. ***Day R, "How to Write and Publish a Scientific Paper***", Cambridge University Press, 2006.
2. ***Goldbort R, "Writing for Science"***, Yale University Press (available on Google Books), 2006.

3. ***Day R, "How to Write and Publish a Scientific Paper",*** Cambridge University Press, 2006.
4. ***Highman N, "Handbook of Writing for the Mathematical Sciences",*** SIAM. Highman's book, 1998.
5. ***Adrian Wallwork, "English for Writing Research Papers",*** Springer New York Dordrecht Heidelberg London, 2011.

Course Outcomes:

Upon completion of the course, the student will be able to:

- **CO1:** Write technical papers in a proper format with clarity and readability.
- **CO2:** Describe the key components of a research paper and choose an appropriate title.
- **CO3:** Develop the writing style of the sections in a manuscript.
- **CO4:** Comprehend the results and discussions with clarity.
- **CO5:** Apply correct style of referencing, identify a good journal and develop a good quality research paper for publication.

Audit Course-I
Disaster Management
(Non-credit Mandatory Course)

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

23MEMA12

Objectives:

CLO1: To provide broad understanding about the basic concepts of disaster management.

CLO2: To be familiar with the concepts of risk assessment and disaster mitigation.

Unit I Introduction **9**

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 **9**

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 **9**

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 **9**

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 and Disaster Mitigation **9**

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. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Total Hours: 45

Reference Books:

1. ***R. Nishith, Singh AK, "Disaster Management in India: Perspectives, Issues and Strategies",*** New Royal book Company, 2004.
2. ***Sahni, Pardeep et.al. (Eds.), "Disaster Mitigation Experiences and Reflections",*** Prentice Hall of India, New Delhi, 2009.
3. ***Goel S. L., "Disaster Administration and Management Text and Case Studies"***, Deep & Deep Publication Pvt. Ltd., New Delhi, 2008.

Course Outcomes:

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

CO1: Differentiate between natural and man-made disasters.

CO2: Deliberate on the repercussions of disasters and hazards and their impact on society, economy and human lives.

CO3: Identify the disaster prone zones in India.

CO4: Analyze the phenomena triggering a disaster, evaluate risk and manage disasters

CO5: Illustrate the concepts of risk assessment and disaster mitigation.

Audit Course-I

Research and Publication Ethics
(Non-credit Mandatory Course)

Semester I **Hours of Instruction/week: 3T**
23MEMA13

Objective:

CLO1: To understand the basics of philosophy of science and ethics, research integrity, publication ethics and identify research misconducts.
CLO2: To understand indexing and citation database, open access publications, research metrics and plagiarism tools.

Unit I Philosophy, Ethics and Scientific Conduct **9**

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions
3. Ethics with respect to science and research
4. Intellectual honesty and research integrity
5. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
6. Redundant publications: duplicate and overlapping publications, salami slicing
7. Selective reporting and misrepresentation of data

Unit II Publication Ethics **9**

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

Unit III Open Access Publishing & Publication Misconduct **9**

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit IV: Publication Misconduct **9**

A. Group Discussions Subject specific ethical issues, FFP, authorship

1. Conflicts of interest
2. Complaints and appeals: examples and fraud from India and abroad

B. Software Tools

1. Use of plagiarism software like Turnitin, Urkund and other open source software tools

Unit V: Databases and Research Metrics **9**

A. Databases

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, HO index, altmetrics

Total hours: 45

Reference Books:

1. ***Bird, A.*** "***Philosophy of Science"***. Routledge, 2006
2. ***MacIntyre, Alasdair*** "***A Short History of Ethics"***. London. 1967
3. ***P. Chaddah***, "***Ethics in Competitive Research: Do not get scooped; do not get plagiarized"***, ISBN:978- 9387480865 2018
4. ***National Academy of Sciences, National Academy of Engineering and Institute of Medicine. On Being a Scientist: A Guide to Responsible Conduct in Research***: Third Edition. National Academies Press. 2009
5. ***Resnik, D. B. What is ethics in research & why is it important*.** National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfrn6.Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a 2011
6. ***Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance***, ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/ Ethics Book. pdf 2019.

Course Outcomes:

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

CO1: Infer the importance of publication ethics, scientific misconduct and honesty
CO2: Apply open access publishing concepts.
CO3: Use available data bases and research metrics for their paper publications.
CO4: Comprehend the philosophy of science and ethics and research integrity.
CO5: Differentiate indexing and citation databases, open access publication and research metrics.

Audit Course-II
Pedagogy Studies
(Non-credit Mandatory Course)

Semester II **Hours of Instruction/week: 3T**
23MEMA21
Objective:

CLO1: To impart knowledge about pedagogy methods
CLO2: To be able to evaluate attainment in learning

Unit I Introduction and Methodology **9**

Understanding student's cognitive and perceptual abilities, Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teaching Learning outcome, Teacher education, Research questions**,** Overview of methodology and Searching.

Unit II Thematic Overview and Learner Intelligences **9**

Pedagogical practices, formal and informal classroom, multiple intelligences, Curriculum and syllabus, adopting teaching methods that appeal to different intelligences

Unit III Evidence on the Effectiveness of Pedagogical Practices **9**

Methodology of teaching, Materials for teaching, support system for effective pedagogical practices, online and blended classrooms, Think-Write-Pair-Share, developing e content, approaches and strategies, engaging learners in the virtual mode, Brain-based learning, Principles of Brain based learning

Unit IV Professional Development **9**

Follow-up support, Peer, Individual, group learning, Barriers to learning, Special Learning Disabilities, Dyslexia, Dysgraphia, Dyspraxia, Dyscalculia. Use of technological tools to enhance learning, Classroom management, online teaching for rural India

Unit V Measuring Attainment in Learning and Future Directions **9**

Difference between assessment and Evaluation, Formative and Summative Assessment, Methods of assessing in classroom, Concept Questions and Peer Instruction, Background Knowledge Probe and Peer Review. Rubrics Methods of Evaluation, Inspiring students to be autonomous learners, online tests, and evaluation (Quizzes. Polling, drag and drop, identification, chat, software tools etc.), motivating students with career guidance and research focus.

Total Hours: 45

Reference Books:

1. http://www.jensenlearning.com/what-is-brain-based-research/
2. ***Anandan, K.N., "Tuition to Intuition"***, Transcent, Calicut, 2006
3. ***Daniel Kenneth Apple, "Process Education: Teaching Institute Handbook :***

Teaching, Learning, Self-grower, Assessment, Facilitation, Curriculum Design", Pacific Crest Software, 1998

4. ***Thomas A. Angelo, K. Patricia Cross, "Classroom Assessment Techniques: A Handbook for College Teachers"***, Wiley, 1993
5. ***Harwell, J. M, "Complete Learning Disabilities Handbooks"***, New York. The Centre for Applied Research in Education, 1989
6. ***Raj, F, "Breaking Through, A Handbook for Teachers and Parents of Children with Specific Learning Disabilities***". VIFA Publications, Secunderabad, 2010.
5. ***Seffetullah Kuldas, Hairul Nizam Ismail, Shahabuddin Hashim***, Unconscious learning processes: mental integration of verbal and pictorial instructional materials

Course Outcomes:

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

CO1: Recognize conceptual framework and enhance teaching learning outcomes.

CO2: Differentiate different pedagogical practices and teaching methodologies.

CO3: Understand teaching methods, identify materials and support systems for effective pedagogical practices.

CO4: Communicate in a better way with learners of diverse cognitive abilities.

CO5: Differentiate between assessment and evaluation, attainment of targeted learning outcomes and appreciate the tools for evaluation.

Audit Course-II
Value Education
(Non-credit Mandatory Course)

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

23MEMA22

Objectives:

CLO1: To understand value of education and self- development

CLO2: To motivate students to imbibe good values.

Unit I Value Education and Human Rights **9**

Value education-Meaning, objectives, importance, Scope and needs. Types-Personal, social, religious, spiritual, universal, cultural and moral values. Values in life and developing a Mission statement. Human rights- meaning, and laws on violation of human rights.

Unit II Values, Goals and Standards **9**

Values, goals and standards-meaning and importance in life. Goals- short term and long term goals. Personal goals, family goals. Relationship among values, goals and standards in life. Standards- meaning and its importance and criteria in setting standards and practicing.

Unit III Human Values and Cultivation of Values **9**

Self-assessment and self-awareness. Importance of cultivation of values-sense of duty, devotion, self-reliance, confidence, concentration, truthfulness, Cleanliness, honesty, humanity, Power of faith, National unity, Love for nature, Discipline. Corporate ethics-Ethical values and global values.

Unit IV Personality and Behavior Development **9**

Social and scientific attitude, developing responsible attitude- Accepting responsibilities in personal and professional life, developing readiness to accept changes in life and society. Integrity and discipline, Effective personality- 7 habits of effective people. Positive thinking- meaning and importance. Understanding positive thinking and self-talk, How to avoid negative thinking, Putting into practice and practicing positive thinking in everyday life.

Unit V Importance of Character and Competence **9**

Character and competence, Achievement motivation, Self-management and good health Importance of religion in life- Holy books vs. Blind faith, Role of women in inculcating moral values in family to nurture good citizens of the society. Self-control-meaning, importance and ways to help improve self-control and build good habits.

Total Hours: 45

Reference Books:

1. ***R.P.Shukla*** "***Value Education and Education for Human Rights***" - Sarup and sons, New Delhi, 2004.
2. ***Chakraborty S.K., "Values and Ethics for Organizations- Theory and Practice***", Oxford University Press, New Delhi, 1998.
3. ***Peale Norman Vincent, "The Power of Positive Thinking***" Edition 1, 2016.
4. ***Home management - Values, Goals and Standards – Brain Kart www.brainkart.com › article › Home-management***
5. ***Frances Bridges "Contributor Careers- Self-control,*** 2018.

Course Outcomes:

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

CO1: Differentiate the values in life and recognize human rights.

CO2: Realize the significance of goals and standards in life.

CO3: Develop good habits and lead a disciplined and meaningful life.

CO4: Accept the responsibilities, develop an effective personality and avoid negative thinking.

CO5: Practice self-control and inculcate moral values to become good citizens of the society.

Professional Certification Course

Digital Manufacturing for Medical Applications

Semester II **No. of credits: 2**

23MEMPC1

Unit I Introduction to Additive Manufacturing and 3D Printing

Introduction to additive manufacturing, rapid prototyping.
Introduction to 3D printing and various 3D printing technologies.
Applications of 3D printing.
Illustration of FDM/FFF 3D printers.
Applications and case studies of 3D printing

Outcomes:

1. Understand the basics of additive manufacturing and rapid prototyping, and their relevance in the field of medical applications.
2. Gain knowledge about the different 3D printing technologies and their applications in medical engineering, prosthetics, and orthotics.
3. Develop an understanding of the various materials used in 3D printing and their properties in medical applications.
4. Learn about the advantages and limitations of 3D printing in medical applications, including its use in surgical planning, implants, and medical devices.
5. Illustrate the principles of FDM/FFF 3D printers and understand their significance in medical applications.
6. Study real-world case studies and examples of 3D printing in the medical field to demonstrate its impact and potential.
7. Develop hands-on experience by using 3D printers to create medical devices, implants, and other relevant applications.
8. Explore the ethical and regulatory issues related to 3D printing in the medical field, such as quality control, safety, and patient privacy.

- By the end of this unit, students should have a comprehensive understanding of additive manufacturing, 3D printing technologies, their medical applications,

Unit II Hands-on with 3D modelling software

Introduction to Computer Aided Designing
Hands-on with open source 3D modelling softwares and tools for 3D printing.
Introduction to 3D printing and slicing parameters
Hands-on with 3D slicing softwares
Operating procedures of 3D printers

Outcomes:

1. Understand the basics of Computer Aided Design (CAD) and its importance in 3D printing.

2. Gain knowledge about the different open-source 3D modelling software and tools for 3D printing and their features.
3. Develop proficiency in using 3D modelling software to create 3D models and design for 3D printing.
4. Understand the different 3D printing technologies and their parameters for slicing and printing 3D models.
5. Develop hands-on experience in using 3D slicing software to prepare 3D models for printing and adjust parameters for optimal results.
6. Learn the operating procedures of 3D printers and the necessary safety measures.
7. Develop practical skills in operating 3D printers to print 3D models accurately and efficiently.
8. Understand common issues that may arise during 3D printing, and how to troubleshoot them.

- By the end of this unit, students should be able to design 3D models using CAD software, prepare them for 3D printing using slicing software, and operate 3D printers effectively. Students should have hands-on experience in using open-source software, and be familiar with the principles of 3D printing and slicing parameters.

Unit III Medical 3D Printing and Its Applications

Introduction and applications of Medical 3D Printing
Introduction and hands-on to prosthetics & bionics using 3D printing.
Methodology and case studies of 3D printed Bionic arm.
Introduction and hands-on with 3D printed Orthotics and exoskeletons.
Introduction to 3D Bioprinting
Introduction to Medical imaging and formats
Hands-on with converting and processing medical DICOM images for 3D printing
Applications of 3D printing DICOM images and Surgical Pre-planning.

Outcomes:

1. Understand the applications of medical 3D printing in healthcare, including its use in prosthetics, bionics, orthotics, exoskeletons, and surgical planning.
2. Develop hands-on experience in using 3D printing to create prosthetics and bionics, and understand their customization and fitting for patients.
3. Gain knowledge about the methodology and case studies of 3D printed bionic arms, including design, manufacturing, and fitting.
4. Develop hands-on experience in using 3D printing to create orthotics and exoskeletons, and understand their customization and fitting for patients.
5. Understand the principles of 3D bioprinting and its potential applications in tissue engineering and regenerative medicine.
6. Gain knowledge about medical imaging and formats, including DICOM images, and their use in 3D printing.
7. Develop hands-on experience in converting and processing medical DICOM images for 3D printing, and understand the importance of accuracy and quality control.

8. Learn about the applications of 3D printing DICOM images in surgical planning, including case studies and examples.

- By the end of this unit, students should have a comprehensive understanding of the applications of medical 3D printing and its potential in healthcare. Students should have hands-on experience in using 3D printing to create prosthetics, bionics, orthotics, and exoskeletons, and be familiar with the principles of 3D bioprinting. They should also have practical skills in converting and processing medical DICOM images for 3D printing and understanding the applications of 3D printing in surgical planning.

Unit IV Introduction to Subtractive Manufacturing

Introduction to CNC milling and routing.
Introduction to LASER cutting and engraving.
Medical Applications of Subtractive Manufacturing.

Outcomes:

1. Understand the basic principles of subtractive manufacturing and its role in modern manufacturing techniques.
2. Gain knowledge about CNC milling and routing, including their applications, advantages, and limitations.
3. Develop hands-on experience in using CNC milling and routing machines to create 2D and 3D designs.
4. Understand the principles of LASER cutting and engraving, including their applications, advantages, and limitations.
5. Develop hands-on experience in using LASER cutting and engraving machines to create 2D designs.
6. Gain knowledge about the applications of subtractive manufacturing in healthcare, including its use in medical devices and instruments.
7. Understand the advantages and limitations of subtractive manufacturing for medical applications.
8. Develop an understanding of the quality control measures required in subtractive manufacturing for medical applications.

- By the end of this unit, students should have a comprehensive understanding of subtractive manufacturing and its role in modern manufacturing techniques. Students should have hands-on experience in using CNC milling, routing, and LASER cutting and engraving machines, and be familiar with their applications, advantages, and limitations. They should also have a good understanding of the applications of subtractive manufacturing in healthcare and be familiar with the quality control measures required for medical applications.

Unit V Mini Project

Ideation, Idea validation and prototyping.

Outcomes:

1. Develop an understanding of ideation and idea validation, including the tools and techniques for generating and evaluating ideas.
2. Gain practical experience in prototyping, including the use of 3D printing and subtractive manufacturing techniques.
3. Develop skills in project planning and management, including setting project objectives, timelines, and milestones.
4. Develop skills in project documentation and presentation, including creating project reports and presenting project outcomes.
5. Develop an understanding of teamwork and collaboration, including effective communication and problem-solving skills.
6. Apply the knowledge and skills gained in the course to develop a digital manufacturing solution for a medical application.
7. Demonstrate creativity and innovation in developing the digital manufacturing solution.
8. Present and communicate the digital manufacturing solution to the class.

- By the end of this unit, students should have the skills and knowledge required to develop a digital manufacturing solution for a medical application. Students should be able to generate and evaluate ideas, develop prototypes using 3D printing and subtractive manufacturing techniques, and manage a project from ideation to presentation. They should also be able to work collaboratively in a team and demonstrate creativity and innovation in their project outcomes. Students should be able to present and communicate their digital manufacturing solution effectively to the class.

Total Hours: 40

Professional Certification Course

Unity Associate Certification – Game Developer

Semester II **No. of credits: 2**

23MEMPC2

Introduction to Unity

Assessing game markets and platforms, marketing methods for games, Video game platforms and genres, describing the game production pipeline, the game design document, the technical design document, creating a new unity project, using the unity asset store, Source control for working in Teams.

Exploring the Unity user interface

Analyzing the unity editor user interface, navigating in the scene view window, utilizing the game view window, Navigating the hierarchy window, Using the inspector window, Managing assets in the project window, Searching and filtering in the project window, organizing the scene with layers.

Unity Game Objects and Assets

Defining unity editor units, Describing assets in the production pipeline, organizing assets in the unity editor, defining a game object, Creating unity native game objects, Manipulating game objects in the unity editor, the role of components in the unity editor, Defining the role of the prefab in unity, Creating and saving a scene, Importing and configuring a 3D model, Importing textures for use in materials, Importing FBX files with animation, Introduction to sprites in game development.

Managing Projects and Assets

Introduction to game project management, using the unity asset store (reprise), importing offline content, Creating project structure based on assets, Sorting the zombie toys pro models assets, Setting resolution and type of texture files.

Preparing Assets for Implementation

Best practices in production: Modeling for games, Animating for games, UV mapping and Texturing techniques, Exporting to Unity, Importing into Unity, The interaction of lighting and materials, Discovering the standard shader in Unity, Exploring other material types, Analyzing the benefits of custom shaders, Creating the materials for zombie toys props, Duplicating and modifying materials, Case studies in material creation, Texturing for game development, Optimization and reuse of textures.

Assembling the Game level

Creating Hierarchies in Unity, Using empty game objects as pivots, Understanding the physics system in unity, Introduction to the rigid body component, Introduction to

colliders, creating the colliders, Introduction to game level design, the level design in zombie toys, Importing the props prefabs into the scene, Cloning the stars, Creating the level boundaries.

Lighting in Games

Introduction to game lighting, Analyzing the different lights and properties, Using layers to exclude objects from lighting, Mesh renderer attributes for shadows, Differentiating shadow types, Creating cookies to shape lights, The benefits of faking shadows in games, Utilizing painted shadows, Utilizing projectors to project shadow cookies, Lighting the Zombie toys scene, Lighting variations for changing the mood in the zombie toys.

Baking Lighting in Game Production

Introduction to Light baking in video games, Marking objects as static for light baking, Creating UV coordinates for Light baking, Continuous and Manual light baking, Placing light probes for moving objects, Creating reflection probes, Creating the light probes in Zombie toys

Animating game objects in the Unity Editor

Introduction to animation in game development, creating animation in the unity editor, refining animation in the unity editor

Bringing Animations into the Game

Introduction to rigging and imported animation, recognizing asset data when importing, differentiating available rig animation types, Creating and naming animation clips, Introduction to the animator controller, Creating and modifying animation states, Creating parameters to control the animation transitions, Creating an Animator override controller

Scripting in Game Development

Creating and saving a script in unity, analyzing the default script methods, attaching a script to a game object, Declaring variables, List of variable types, Introduction to conditions, The & quot;if & quot; condition, The & quot ; if else & quot; condition, Complex conditions, Introduction to looping, The " while & quot; loop,The "for" loop, The benefits of using custom methods, Utilizing arguments, Utilizing method return types, Introduction to coroutines, Utilizing the getcomponet () function, Examining common game project code.

Implementing Navigation and Pathfinding

Introduction to Navigation in Unity, Describing a NavMesh, Defining a NavMesh Agent, Describing a NavMesh Obstacle

Building the player and Allies

Examining why to use a custom controller, Creating the player controller game object, Explaining the purpose off the game manage, Adding scripts for behavior, Configuring the camera, Building the sheep Ally from a model, Building the Dog Ally from a model.

Building the enemies

Designing the enemy behaviors, Creating the First enemy character, Creating the enemy animator controller, Creating the zombear enemy, Creating the zombie duck enemy, Creating the other enemies, Placing the spawn points, Spawning the enemies.

Creating particle systems

Examples of Unity particles in video games, Comparing effects for games with other media

Introduction to Unity Particle System, Analyzing existing particle effects, Setting up the interface for effects, Overview of the lightning attack, Building the lightning attack Hit, Building the lightning attack emitter, Building the lightning Bolt, Integrating the lightning attack into the game, Introduction to the Frost Attack, Building the Frost Debuff, Building the Frost Attack Emitter, Building the Frost cone effect, Integrating the Frost Attack into the game, Introduction to the stink bomb attack, Creating the stink Bomb Hit effect, Creating the stink bomb attack reticle, Building the stink bomb attack emitter, Building the stink projectile, Integrating the stink bomb into the game, Introduction to the slime attack, Creating the slime Hit effect, Creating the slime Debuff, Creating the slime attack reticle, Building the slime attack emitter, Building the slime projectile, Integrating the slime attack into the game, Adding the Ally Manager.

Adding Audio to Game levels

Introduction to Audio in game development, Introduction to importing audio into Unity, Audio listeners and Audio sources, testing audio sources in the scene, Using Audio Mixers and Mixer groups, setting up the Zombie Toys Audio mixers, Introduction to Audio Effects, Adding Audio to the Characters, Implementing Audio Ducking.

Building the camera and Player selection system

Analyzing the player selection system, making the player selectable, Adding another player, Adding camera animations, configuring the camera animator controller, Applying behaviors to the camera, Adding character selection spotlights.

Designing user interfaces for games

Assessing user interface design needs, Examining the UI tools in the Unity editor, Investigating the Canvas functionality, Utilizing the power of the Rect Transform, Creating a UI button, Creating a UI Image, Creating UI Text, Creating Interaction in the UI with events.

Building and deploying the game

Introduction to the build process, adjusting the player settings, Building the game, unlocking the unity platform potential, Surveying Unity services.

Preparing for Mobile deployment

Introduction to mobile development in Unity, Changing the build platform to Mobile, Adding the mobile interface UI, Implementing Mobile input bhaviors

Total Hours: 40