Department of Medical Electronics

BMS College of Engineering, Bangalore

Scheme and Syllabus: V & VI Semester

Academic Year: 2016- 2017

B M S COLLEGE OF ENGINEERING

(Autonomous College under VTU)

INSTITUTE VISION & MISSION

VISION

Promoting Prosperity of mankind by augmenting human resource capital through quality Technical Education & Training

MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT VISION & MISSION

VISION

To promote quality education in Medical Electronics Engineering for health and well-being of humankind through teaching and research platforms.

MISSION

- **To impart knowledge and skills necessary for professional development of graduates in Medical Electronics Engineering.**
- **To provide continuous up gradation of technical education with strong academic progression.**
- **To propagate creativity, responsibility, commitment and leadership qualities and exhibit professional ethics and values.**

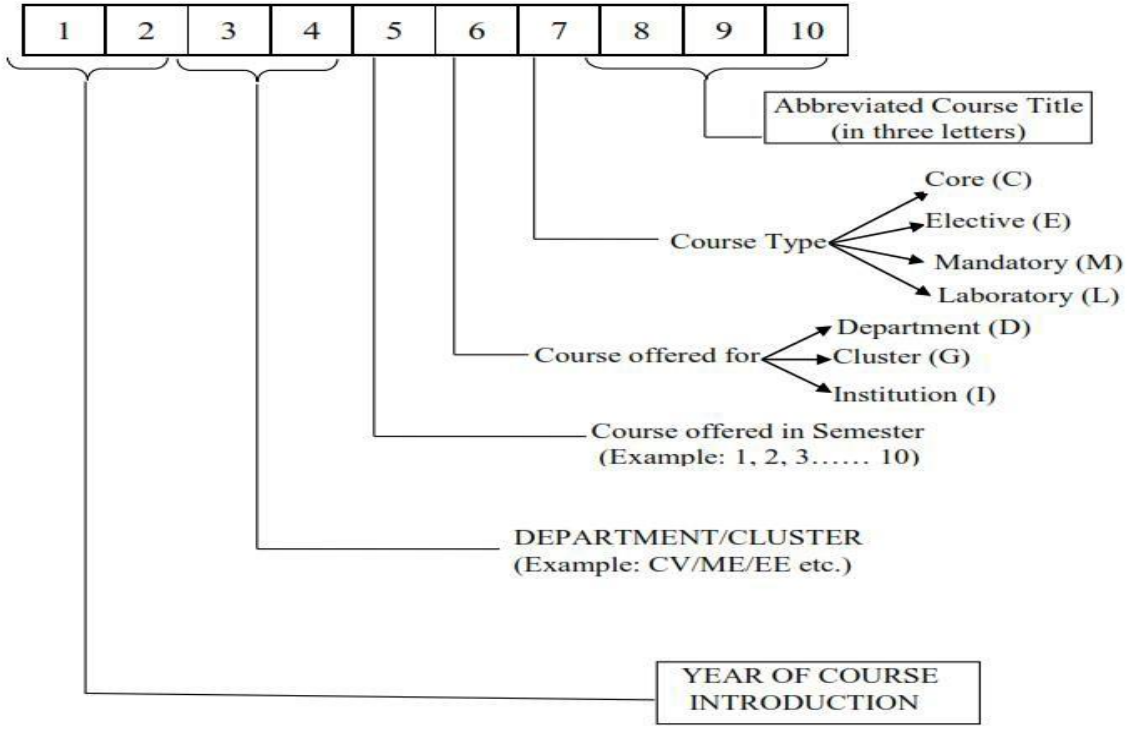
Program Educational Objectives

PEO1	Graduates will make a successful career in the field of healthcare and allied engineering fields
PEO2	Graduates will demonstrate the ability to work as a member of a professional team with effective communication skills and function as a responsible individual.
PEO3	Graduates will use undergraduate foundation to pursue higher studies, research and will participate in life-long learning throughout their careers

Program Outcomes

PO1	An ability to apply knowledge of mathematics, science and engineering fundamentals for appropriate solutions to Medical electronics.
PO2	An ability to identify, analyze a problem, and formulate the computing requirements appropriate **to** its solution.
PO3	An ability to design, implement and evaluate an electronic/computer-based system, process to meet desired needs in healthcare.
PO4	An ability to design experiments, as well as to analyze and Interpret Medical data.
PO5	An ability to use current techniques and modern tools necessary for computing practice leading to improvised health care.
PO6	An ability to understand health and safety issues through medical electronics concepts.
PO7	An ability to understand environmental considerations and sustainable engineering solutions in Medical Electronics.
PO8	An ability to understand professional ethics and legal issues related to healthcare technologies.
PO9	An ability to function effectively as an individual and a member in diverse team.
PO10	An ability to communicate effectively with a range of audiences.
PO11	An ability to understand management principles and apply these to manage projects and finance.
PO12	An ability to engage in continuing professional development for lifelong learning.

NOMENCLATURE FOR THE COURSE CODE



Program: **Medical Electronics** Semester: **V**

Course Code										Course Title	Credits				Credits	CIE	SEE	Total
											L	T	P	SS				
1	6	M	L	5	D	C	E	S	D	Embedded Systems Design	3	0	0	0	03	50	50	100
1	6	M	L	5	D	C	B	M	I	Biomedical Instrumentation	3	0	1	2	06	50	50	100
1	6	M	L	5	D	C	B	M	R	Biomechanics and Rehabilitation	2	1	0	0	03	50	50	100
1	6	M	L	5	D	C	D	S	P	Digital Signal Processing	3	0	1	2	06	50	50	100
1	6	M	L	5	D	C	M	D	P	Medical Physics	2	1	0	0	03	50	50	100
1	6	M	L	5	D	E	1	X	X	Department Elective-I	3	0	1	0	04	50	50	100
										TOTAL	**16**	**3**	**2**	**4**	25	300	300	600

Program: Medical Electronics Semester: **VI**

Course Code										Course Title	Credits				Credits	CIE	SEE	Total
											L	T	P	SS				
1	6	M	L	6	D	C	M	I	P	Medical Image Processing	3	0	1	2	06	50	50	100
1	6	M	L	6	D	C	B	S	P	Bio-Medical Signal Processing	2	0	1	0	03	50	50	100
1	6	M	L	6	D	C	B	M	A	Bio-Materials and Artificial Organs	2	1	0	0	03	50	50	100
1	6	M	L	6	D	C	M	D	D	Medical Device Development	3	0	1	2	06	50	50	100
1	6	M	L	6	D	C	M	I	M	Medical Imaging Modalities	3	1	0	0	04	50	50	100
1	6	M	L	6	G	E	1	X	X	Cluster Elective-I	3	0	0	0	03	50	50	100
										TOTAL	16	2	3	4	25	300	300	600

Program: Medical Electronics

Department Elective: Group-I

Course Code										Course Title	Credits				Credits	CIE	SEE	Total
											L	T	P	SS				
1	6	M	L	5	D	E	1	P	R	Pattern Recognition & Neural Networks	3	0	1	0	04	50	50	100
1	6	M	L	5	D	E	1	O	P	OOPs with C++ for Medical Applications	3	0	1	0	04	50	50	100
1	6	M	L	5	D	E	1	B	C	Brain Computer Interface	3	0	1	0	04	50	50	100

Program: Medical Electronics

Cluster Elective: Group-I

Course Code										Course Title	Credits				Credits	Contact Hours	CIE	SEE	Total
											L	T	P	SS					
1	6	M	L	6	G	E	1	B	M	Bio-MEMS	3	0	0	0	03	03	50	50	100
1	6	M	L	6	G	E	1	I	P	Advanced Medical Image Processing	3	0	0	0	03	03	50	50	100

V SEMESTER

DEPARTMENT CORE

Course Title	EMBEDDED SYSTEMS DESIGN & MEDICAL APPLICATIONS	Course Code	16ML5DCESD
Credits	03	L-T-P-S	3-0-0-0

Course Outcomes

CO1: Ability to apply knowledge of mathematics, science and engineering to learn design aspects of embedded systems.

CO2: Ability to identify analyze a problem and formulate the computing requirements appropriate to its solution.

CO3: Ability to work in a team to explore, identify, conceptualize and present ideas to design a system within realistic constraints such as environmental, social, ethical, health and safety, and sustainability for applications in healthcare

UNIT I **[7 hours]**

Introduction: Processor Embedded into a system, Embedded Hardware units and Devices in a system, Embedded Software in a system, Examples of embedded systems, embedded system-on-chip (Soc) and use of VLSI Circuit design technology, complex systems design and processors, design process in embedded systems, formalization of system design, classification of embedded systems, skills required for an embedded system designer.

UNIT II **[8 hours]**

Devices and communication buses for devices network: IO types and examples, serial communication devices, parallel device ports, timer and counting devices, watchdog timer, Real time clock, networked embedded systems, serial bus communication protocols.

UNIT III **[9 hours]**

Device drivers and interrupts service mechanism: Programmed-I/O busy-wait Approach without interrupt service mechanism, ISR concept, interrupt sources, interrupt servicing mechanism, multiple interrupts, context and the periods for the context switching, interrupt latency and deadline, device driver programming.

UNIT IV **[8 hours]**

Program modelling concepts, IPC and Synchronization: Program models, DFG models, state machine programming models for event-controlled program flow, modelling of multiprocessor systems. Multiple processes/Threads, Semaphores, Shared data, IPC, Functions of Mail box, Pipes and Sockets.

UNIT V **[7 hours]**

Real-time operating systems: OS services, process management, timer functions, memory management, interrupt routines in RTOS environment and handling of interrupt source calls, real-time operating systems, basic design using an RTOS, RTOS task scheduling models, interrupt latency and response of the tasks as performance metrics.

Text Books

1. Raj Kamal, Embedded systems, TMH.

Reference books

1. Shibu K.V, embedded system design, TMH
2. Jack Ganssle Embedded Systems, Newnsess

E-books

1. https://en.wikibooks.org/wiki/Embedded_Systems
2. read.pudn.com/

E-course

1. http://nptel.ac.in/courses/108102045
2. https://www.coursera.org

Course Title	BIOMEDICAL INSTRUMENTATION	Course Code	16ML5DCBMI
Credits	06	L-T-P-S	3-0-1-2

Course Outcomes

CO1: Ability to apply knowledge of mathematics science and engineering fundamentals in designing, analyzing and/or working of biomedical circuits and instruments.

CO2: Understand the health, safety, Environmental, legal and ethical issues while designing/working of a biomedical circuits and instruments.

CO3: Ability to work, document and present as an individual and as a team-member to design, formulate and implement experiments using modern equipment's & tools.

CO4: Ability to present in a group and document the findings or suggestions for the problems in the current techniques, modern tools and computing practice to improve technology in health care instruments through hospital visits for lifelong learning.

UNIT I **[08 Hours]**

Physiological Transducers: Classification of transducers, performance characteristics of transducers. Pressure transducers, transducers for body temperature measurement, photoelectric transducers, optical fiber sensor, biosensor and smart sensor. Biomedical recorders and biofeedback instruments.

Patient Monitoring Systems: System concepts, cardiac monitor, bedside patient monitoring system, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate, catheterization laboratory instrumentation.

UNIT II **[08 Hours]**

Oximeters: Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. Blood Flow Meters: Electromagnetic blood flow meters-different types, Ultrasonic blood flow meters, NMR blood flow meters and Laser Doppler blood flow meters.

Cardiac output measurements: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of continuous cardiac output derived from the aortic pressure waveform, Impedance technique.

Pulmonary Function Analyzer: Pulmonary function measurement, Spirometry, Pneumotachometer, Measurement of volume by Nitrogen washout technique.

UNIT III **[08 Hours]**

Blood Gas Analyzers: Acid-base balance, blood pH measurement, measurement of blood pCO2, intra-arterial blood gas monitoring, complete blood gas analyzer.

Audiometer and Hearing Aids: Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system, Bekesy evoked response audiometer system, calibration of audiometer and hearing aids.

UNIT IV **[08 Hours]**

Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker, External Pacemaker, Implantable pacemaker, Types of Implantable pacemakers and recent developments.

Programmable pacemaker, Rate-responsive pacemakers, pacing system Analysers, Need for Defibrillator, Dc defibrillators, Implantable Defibrillators, Defibrillator analysers.

UNIT V **[07 Hours]**

Instruments of Surgery: Principles of surgical diathermy, surgical diathermy Machine, Safety aspects in electro- surgical units, surgical diathermy Analyzer.
Automated drug delivery Systems: Infusion pumps, components of drug infusion systems and implantable infusion systems.
Patient Safety: Electric shock hazards, Leakage currents, safety codes and analyzer. Ethical issues in the design of Biomedical Instruments.

Text Books:

1. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003
2. J. G. Webster, Biomedical Instrumentation, John Wiley and Sons, Hoboken, NJ, 2004.

Reference Books:

1. Leslie Cromwell, Fred J. Weibell, Eric A. Pfeiffer, Biomedical Instrumentation and Measurements, PHIn
2. Biomedical Instrumentation by Dr.M. Arumugam-Second Edition- 1994

E-Books:

1. http://www.ebook3000.com/Introduction-to-Biomedical-Instrumentation--The-Technology-of-Patient-Care_51854.html
2. Barbara Christe, Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press | 2009 | ISBN: 0521515122

MOOC Courses

1. Ma, Hongshen. 2.996 Biomedical Devices Design Laboratory, Fall 2007. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/mechanical-engineering/2-996-biomedical-devices-design-laboratory-fall-2007 (Accessed 27 Jul, 2014). License: Creative Commons BY-NC-SA
2. Lauffenburger, Douglas, Paul Matsudaira, Biological Engineering Faculty, and Angela Belcher. 20.010J Introduction to Bioengineering (BE.010J), Spring 2006. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-to-bioengineering-be-010j-spring-2006 (Accessed 26 Jul, 2014). License: Creative Commons BY-NC-SA

Course Title	BIOMECHANICS AND REHABILITATION	Course Code	16ML5DCBMR
Credits	03	L-T-P-S	2-1-0-0

Course Outcomes

CO1: Ability to apply knowledge of mathematics science and engineering to understand the fundamentals of moving systems and familiarity with human anatomy to competently analyze the movement of the human body.

CO2: Ability to analyze the dynamics of human movement and comprehend the biomechanical principles that relate to movement and communication disabilities.

CO3: Ability to discuss, develop and apply the principles of biomechanics to a range of rehabilitation strategies and problem solving.

CO4: capable of reading, comprehending and communicating the content of contemporary technical articles on biomechanical research and applications.

UNIT I **[5 Hours]**

Introduction to Biomechanics –What Is Biomechanics, Mechanics In Physiology. Definition Of Stress, Strain And Strain Rate, The Non viscous Fluid, Newtonian Viscous Fluid, The Hookean Elastic Solid, Viscoelasticity, Response Of A Viscoelastic Body To Harmonic Excitation, Use Of Viscoelastic Models ,Methods Of Testing .

The Flow Properties of Blood-Blood rheology, the constitutive equation of blood based on viscometric Data and casson's equation, Laminar flow of blood in tube, blood with viscosity described by casson's equation.

UNIT II **[5 Hours]**

Bioviscoelastic fluids: Introduction, small deformation experiments, mucus from the respiratory tract, saliva, cervical mucus and semen, synovial fluid, flow properties of synovial fluid,

Bioviscoelastic solids: Introduction, some elastic materials-actin, elastin, resilin and abduction, fibers, collagen, Quasi-linear viscoelasticity of soft tissues, the concept of pseudo-elasticity.

UNIT III **[6 Hours]**

Introduction to Rehabilitation and Rehabilitation Team: What is Rehabilitation? Epidemiology of Rehabilitation, Health, Levels of pevention, Preventive Rehabilitation, Diagnosis of Disability, Functional, Diagnosis, Importance of Physiatry in Functional Diagnosis, Impairment Disability Handicap, Primary and Secondary disabilities, Effects of Prolonged inactivity and Bed rest on body system.

Rehabilitation Team: classification of members, The role of members, The Role of Physiatrist, Occupational therapist, Recreation therapist, Prosthetist- Orthotist, speech pathologist, Rehabilitation nurse, social worker, Corrective Therapist, Psychologist, Music therapist, Dance therapist and Biomedical Engineer.

UNIT IV **[05 Hours]**

Therapeutic Exercise Technique: Co-ordination exercises, Freckles exercises, Gait analyses-pathological Gaits, Gait Training, Relaxation Exercises- Methods for training Relaxation, Strengthening exercises- strength training, Types of contraction, Mobilization exercises, Endurance Exercises

UNIT V **[05 Hours]**

Principles in management of communication:
Impairment –introduction to communication, Aphasia, Types of Aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, hearing aids, Types of conventional hearing aid, writing aids.

TEXT BOOKS:

1. Biomechanics- Mechanical Properties of Living tissues -Y.C.Fung -Second Edition- Springer Verlag.
2. Text book of Rehabilitation- S Sunder- 3rd Edition-Jaypee Brothers Medical Publishers (P) Ltd. New Delhi

REFERENCE BOOKS:

1. Biomechanics principles and applications by Schneck and Bronzino, CRC Press, 2003
2. Physical Rehabilitation by Susan B O'Sullivan, Thomas J Schmitz. 5th Edition

E-Books
1. https://booksfree4u.tk/download-biomechanics-ebook-pdf-free/
2. www.profedf.ufpr.br/.../Books/Duane%20Knudson-%20Fundamentals%...

Online-courses:
1. www.biomechanics-education.com/courses.php
2. https://www.mooc-list.com/tags/biomechanics?static=true

Course Title	DIGITAL SIGNAL PROCESSING	Course Code	16ML5DCDSP
Credits	06	L-T-P-S	3-0-1-2

Course Outcomes

CO1 To apply knowledge of Mathematics and Engineering to convert analog to digital Bio signals.

CO2 An ability to apply technique to arrive at real time Biomedical signal applications.

CO3 An ability to formulate specifications for analysis and interpretation of biosignals.

CO4 An ability to use current techniques and modern tools to improve the Medical data analysis. Present and document the same.

UNIT I [9 HOURS]

Introduction to DSP, Sampling and reconstruction of a discrete time signal in the frequency domain. Definition of Discrete Fourier Transform (DFT). Useful properties of DFT : linearity, circular shift, Multiplication by a complex exponential sequence, Properties of even and odd parts of x[n], Multiplication, Parseval's relation, Circular convolution in the time domain ,use of tabular arrays and circular arrays

UNIT II [8 HOURS]

Use of DFT in linear filtering, linear convolution of two finite duration sequences, overlap add and save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in frequency algorithms. Radix 2 FFT algorithm for computation of Inverse Discrete Fourier Transform. (IDFT)

UNIT III [8 HOURS]

Introduction to realization of digital systems, block diagrams representation, Realization of Infinite Impulse Response (IIR) systems: direct form, parallel form, cascade form. Introduction to IIR filters, Impulse invariant & Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital Butterworth and Chebyshev filters.

UNIT IV [8 HOURS]

Realization of Finite Impulse Response (FIR) systems : Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, high pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Kaiser and Hamming window.

UNIT V [6 HOURS]

Introduction to Multirate Digital Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling conversion by a Rational factor I/D, Filter Design and implementation for sampling rate conversion. Direct form FIR Filter structure, Polyphase filter

structures, Time Variant filter structures. Signal Averaging: Basics of signal averaging, Typical Signal Averager, Signal averaging as a Digital Filter.

TEXT BOOKS:

1. Digital Signal Processing, A computer based approach, Sanjit K Mitra, Tata McGrawHill, Third Edition
2. Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris K Manolakis, Pearson education/PHI, (4th Edition)

REFERENCE BOOKS:

1. Fundamentals of Digital Signal Processing, Lonnie Ludeman, John Wiley & Sons; Wiley International 1st Edition, 1988.
2. Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999

E-books

1. The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.
2. Digital Signal Processing Principles, Algorithms, and Applications Third Edition John G. Proakis Northeastern University Dimitris G. Manolakis

MOOC Courses

1. https://www.coursera.org/course/dsp
2. https://www.mooc-list.com/course/applied-digital-signal-processing

Course Title	MEDICAL PHYSICS	Course Code	16ML5DCMDP
Credits	03	L-T-P-S	2-1-0-0

Course Outcomes

CO1: Ability to apply the knowledge of mathematics, science and engineering to understand the concepts of Human Physiology

CO2: Ability to identify and analyze a problem related to physics in heat, energy, work, power, pressure, sound and light applied to human body

CO3: Ability to understand the health and safety issues through physics concepts applied to human body

CO4: Ability to function and engage in communicating the recent trends in medical Physics.

UNIT I: [5 Hours]

Metabolism: Energy, Heat, Work, and Power of the Body: Conservation of Energy and Heat flow, Energy content of body fuel, Metabolic rates, loss of Body Heat, Body temperature.

UNIT – II: [6 Hours]

Fluids Pressure, Fluid Flow in the Body, and Motion in Fluids: Characteristics Pressures in the Body, Basic physics of pressure and flow of fluids, Pressure and flow in the body, Motion of Humans in Fluids.

UNIT III [6 Hours]

Cardiovascular system: Physics of cardiovascular system: Properties of Blood, Blood Pressure and flow in vessels—measuring flow in blood vessels, Modeling flow in Blood Vessels, Pressure Drops in arteries and resistive Vessels, Blood flow rates and speeds, consequences of clogged Arteries, work done by heart and the metabolic needs of the heart .

Modeling the Circulatory System and the Heart: Model of the Heart, Model of the overall flow of the circulatory System, the arterial Pulse, Windkessel Model, Modeling the malfunctioning Heart.

UNIT IV: [5 Hours]

Sound, Speech and Hearing: The physics of sound waves: Absorption of sound, Resonant cavities. Speech production: types of sounds, systems in speech production(exclude voice-filtering theory), parameters of the human voice, the energies of speaking, Hearing(exclude the immittance of the human ear),other vibrations of the body

Laser applications in Medicine: Nd-Yag Laser, CO_2 Laser, Pulsed Ruby Laser

UNIT V [5 Hours]

Light, Eyes and Vision: Focusing and imaging with lenses: image formation, scientific basis for imaging, moving lenses. Imaging and detection by the eye: the eye as a compound lenses, accommodation, field of vision and binocular vision, adjustments of light levels, limitation to visual acuity, imperfect human vision, correction of the visions, Types of visual impairment, connections to visual perceptions.

TEXT BOOKS:

1. Herman I.P., Physics of the Human Body, Springer Publications, 2007
2. Dr. R.N.Roy "Medical biophysics", Books and Allied(P) Ltd. 1st Edition,2001,

REFERENCE BOOKS:

1. Paul Davidovits "Physics in Biology and Medicine " , Academic Press, 3rd Edition, 2007

2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose "MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING", Medical Science Series© IOP Publishing Ltd 1999

E-BOOKS:

1. Hand Book of Biomedical Instrumentation-R S Khandpur-2rd Edition-2003-Tata McGraw-Hill Publishing company Limited, New Delhi
2. Biological and Medical Physics ,Biomedical Engineering- Physics of the Human Body, Irving .P .Herman, Springer Publications, 2008

MOOC Courses

1. http://apam.columbia.edu/medical-physics-ms-program
2. http://www.medsci.ox.ac.uk/study/bms

DEPARTMENT ELECTIVE-I

Course Title	PATTERN RECOGNITION & NEURAL NETWORKS	Course Code	16ML5DE1PR
Credits	04	L-T-P-S	3-1-0-0

Course Outcomes

CO1: Ability to describe why a particular model is appropriate in a given situations, formulate the model and use it appropriately.

CO2: Ability to analytically demonstrate how different models and different algorithms are related to one another.

CO3: Ability to implement a set of practical methods and program solutions to some given real world machine learning problems.

CO4: Ability to justify why a given model is appropriate for the situation and develop an algorithm from a given model

CO5: Ability to design and compare machine learning methods, and discuss how different methods relate to one another and will be able to develop new and appropriate machine learning methods appropriate for particular problems.

Unit I **[8 hours]**

Introduction: Applications of pattern recognition, statistical decision theory, image processing and analysis, the internet, pointers to literature. Probability: Introduction, Probability of events, random variables, joint distribution & densities, moments of random variables, estimation of parameters from samples, minimizing risk estimators.

Unit II **[8 hours]**

Statistical decision making: Introduction, Bayes theorem, multiple feature, conditionally independent feature, decision foundries, unequal costs of error, estimation of error rates the living one out technique characteristics curves estimating the composition of populations.

Unit III **[8 hours]**

Nonparametric decision making: introduction, histogram, kernel & window estimators, nearest neighbour classification techniques, adaptive decision boundaries, adaptive. Clustering: Introduction, hierarchical clustering and partitional clustering.

Unit IV **[7 hours]**

Basic concepts of neurocomputing, Basic terminology related to an artificial neuron, The Perceptron, Linear Networks.

Unit V **[8 hours]**

Multi-Layer Feedforward Neural Networks, Self-Organising systems & Feature Maps, Recurrent networks.

Text Books:

1. Pattern recognition & image analysis (chapter 1 to Chapter 6) Earl Gose, Richard Johnson Baugh & Steve Jost, PHI.
2. Pattern Recognition Statistical structural & neural approaches, Robert J Schalkof, John Wiley, 1992.

Reference Books:

1. Richard O. Duda, Peter E. Hart, and David G.Stork: Pattern Classification, 2nd Edition, Wiley-Interscience, 2001.

2. K. Jain, R. Bolle, S. Pankanti: Biometrics: Personal Identification in Networked Society, Kluwer Academic, 1999.

Ebook

1. Neural Network and Pattern Recognition, Christopher M Bishop, Aston University, UK, 1995 (http://cs.du.edu/~mitchell/mario_books/Neural_Networks_for_Pattern_Recognition_-_Christopher_Bishop.pdf)
2. Neural Network Design, Oklahoma University (http://hagan.okstate.edu/NNDesign.pdf)

Online courses

1. https://www.coursera.org/learn/machine-learning/home/welcome
2. http://nptel.ac.in/courses/117108048/

Course Title	OBJECT ORIENTED PROGRAMMING USING C++ FOR MEDICAL APPLICATION	Course Code	16ML5DE1DS
Credits	04	L-T-P-S	3-1-0-0

Course outcomes

CO1. Able to differentiate between structure oriented programming and object oriented programming and use object oriented programming language like C++ and associated libraries to develop object oriented programs for handling Medical data

CO2. Ability to identify, analyze and apply the concepts of classes, Objects and other advanced OOPs concepts like inheritance, data abstraction, encapsulation, operator overloading, functions, polymorphism, exception handling and use built-in classes from STL for Medical data management

CO3. An ability to formulate, design, implement, analyze, demonstrate, document and present the concepts implemented in groups or individual.

UNIT I **[8 hours]**

OOPS paradigm-Programming language, Object-Oriented Programming, Object-Oriented Languages, Basic concept of oops-Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Brief History of C++, Applications of OOPS concepts in Medicine.

Data types & Variables- Structure of a C++ program, Comments, Variables, Identifiers, Data types. Declaration of variables, Initialization of variables, Scope of variables, Constants, Operators and Control Structures -Types of Operators. Priority of Operators.

UNIT II **[6 hours]**

Structures and Unions, User defined data types.

Functions - Returning values from functions. Reference arguments. Overloaded function. Inline function. Default arguments. Returning by reference, Constructors and Destructors, Applications of functions in Medicine

UNIT III **[8 hours]**

Arrays- Initializing arrays, Strings, Pointers. Pointers and arrays, Dynamic Memory.

Classes and Objects- Introduction to class, Class Definition, Classes and Objects, Access specifiers – Private, Public and Protected. Member functions of the class, Object as data types constructor. Object as function arguments. The default copy constructor, returning object from function. Structures and classes. Classes objects and memory static class data. Const and classes, Applications of classes and objects in Medicine

UNIT IV **[8 hours]**

Function Overloading- Precautions to be taken while overloading functions. Static Class Members, Static Member Functions, Friend Functions

Operator Overloading- Introduction to Operator Overloading, Operator Overloading fundamentals, implementing the operator functions.

Inheritance- Reusability, Inheritance concept-single inheritance. Using the derived class, Constructor and destructor in derived class, Object initialization and conversion, Types of Inheritance, Nested classes, Virtual base class, Applications of Inheritance in Medicine.

UNIT V **[8 hours]**

Pointers- Addresses and pointers. The address of operator and pointer and arrays. Memory management- New and Delete, pointers to objects, debugging pointers.

Virtual Function- friend function, Static function, Assignment and copy initialization, this pointer, dynamic type information
Streams and Files- Streams classes, Stream Errors, Disk File I/O with streams, file pointers, error handling in file I/O with member function, overloading the extraction and insertion operators, memory as a stream object, command line arguments, and printer output.
Templates and Exceptions- Function templates, Class templates Exceptions
The Standard Template Library- Introduction algorithms, sequence containers, iterators, specialized iterators, associative containers, strong user-defined object, function objects. Applications in Medicine.

Text Books:

1. Object Oriented Programming in C++ by Robert Lafore Techmedia Publication.
2. Object Oriented Programming with C++, E Balaguruswamy, Third edition, TMH2006

Reference Books:

1. The complete reference C – by Herbert shieldt Tata McGraw Hill Publication.
2. C++ the complete reference, Herbert Schildt, Fourth edition, TMH, 2003.

E-Books:

1. www.ddegjust.ac.in/studymaterial/mca-3/ms-17.pdf
2. https://programesecure.com/balaguruswamy-c-pdf-free-download/

MOOC Courses:

1. https://www.mooc-list.com/course/object-oriented-programming-java-coursera
2. https://www.mooc-list.com/course/object-oriented-programming-edx

Course Title	BRAIN COMPUTER INTERFACE	Course Code	16ML5DE1BC
Credits	03	L-T-P-S	3-0-0-0

Course Outcomes

CO1. Ability to apply the knowledge of mathematics science and engineering fundamentals to understand the Brain Organization, Anatomy, and Function.
CO2. Ability to analyze and process the brain signals for artifact reduction.
CO3. Ability to understand types of BCI, principles and its applications which are present state of art in the Neurosciences domain.

UNIT I **[07 Hours]**

Basic Neurosciences: Basic Neuroscience: Neurons, Action Potentials or Spikes, Dendrites and Axons, Synapses, Spike Generation, Adapting the Connections: Synaptic Plasticity – (LTP, LTD, STDP, Short-Term Facilitation and Depression), Brain Organization, Anatomy, and Function.

Recording and Stimulating the Brain: Recording Signals from the Brain: Invasive Techniques & Noninvasive Techniques. Stimulating the Brain - Invasive Techniques & non-Techniques. Simultaneous Recording and Stimulation: Multi-electrode Arrays, Neurochip.

UNIT II **[08 Hours]**

Signal Processing for BCI's: Spike Sorting, Frequency Domain Analysis: Fourier analysis, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Spectral Features, Wavelet Analysis. Time Domain Analysis: Hjorth Parameters , Fractal Dimension , Autoregressive (AR) Modeling, Bayesian Filtering, Kalman Filtering, Particle Filtering), Spatial Filtering : (Bipolar, Laplacian, and Common Average Referencing ,Principal Component Analysis (PCA) ,Independent Component Analysis (ICA) , Common Spatial Patterns (CSP)

Artifact Reduction Techniques: Thresholding, Band-Stop and Notch Filtering, Linear Modeling, Principal Component Analysis (PCA), Independent Component Analysis (ICA).

UNIT III **[07 Hours]**

Building a BCI: Major Types of BCIs: Brain Responses Useful for Building BCIs: Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity.

Invasive BCIs: Two Major Paradigms in Invasive Brain-Computer Interfacing: BCIs Based on Operant Conditioning, BCIs Based on Population Decoding.

UNIT IV **[09 Hours]**

Invasive BCIs in Humans: Cursor and Robotic Control Using a Multielectrode Array Implant, Cognitive BCIs in Humans, Long-Term Use of Invasive BCIs, Long-Term BCI Use and Formation of a Stable Cortical Representation, Long-Term Use of a Human BCI Implant

Semi-Invasive BCIs: Electrocorticographic (ECoG) BCIs -ECoG BCIs in Animals, ECoG BCIs in Humans, BCIs Based on Peripheral Nerve Signals Nerve-Based BCIs, Targeted Muscle Innervation (TMR).

Non-Invasive BCIs: Oscillatory Potentials and ERD, Slow Cortical Potentials, Movement-Related Potentials, Stimulus Evoked Potentials; BCIs Based on Cognitive Tasks, Error Potentials in BCIs, Co-adaptive BCIs, Hierarchical BCIs.

Other Noninvasive BCIs: fMRI, MEG, and fNIR: Functional Magnetic Resonance Imaging Based BCIs, Magnetoencephalography Based BCIs, Functional Near Infrared and Optical BCIs.

BCIs that Stimulate: Sensory Restoration, Restoring Hearing: Cochlear Implants, Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS), Sensory Augmentation.

UNIT V **08 Hours**

Medical Applications: Sensory Restoration, Motor Restoration, Cognitive Restoration, Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs,

Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars, High Throughput Image Search Lie Detection and Applications in Law , Monitoring Alertness, Estimating Cognitive Load, Education and Learning, Security, Identification, and Authentication, Physical Amplification with Exoskeletons, Mnemonic and Cognitive Amplification , Applications in Space, Gaming and Entertainment, Brain-Controlled Art.

Ethics of Brain-Computer Interfacing: Medical, Health, and Safety Issues, Balancing Risks versus Benefits, Informed Consent, Abuse of BCI Technology, BCI Security and Privacy, Legal Issues, Moral and Social-Justice Issues.

TEXT BOOKS:

[1] Brain-Computer Interfacing: An Introduction (1st Edition) by Rajesh P. N. Rao

[2] Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction (The Frontiers Collection) Hardcover – (13 Dec 2010) by Bernhard Graimann (Editor), Brendan Z. Allison (Editor), Gert Pfurtscheller (Editor)

Ebook:

1. http://self.gutenberg.org/articles/brain-machine_interface
2. http://www.cosy.sbg.ac.at/~held/teaching/wiss_arbeiten/slides_05-06/BCI.pdf

Online Courses

1. https://www.coursera.org/learn/computational-neuroscience
2. https://www.coursera.org/learn/synapses

VI SEMESTER

DEPARTMENT CORE

Course Title	MEDICAL IMAGE PROCESSING	Course Code	16ML6DCMIP
Credits	06	L-T-P-S	3-0-1-2

Course Outcomes

CO1. Ability to apply knowledge of mathematics, science and engineering to develop medical image processing processes/systems.
CO2. Ability to analyze a problem and formulate appropriate solution for medical image processing applications.
CO3. Ability to design experiments in medical image processing and analyze computer based process to meet desired needs in healthcare.
CO4. Ability to work, document and present an individual and as a team member to design formulate and implement experiments using modern tools.
CO5. Ability to engage in self-study for lifelong learning to explore computing requirements for medical image processing

UNIT I **[7 hours]**

Fundamentals: Introduction, Fundamental steps in DIP, Components of DIP system, A simple image formation model, Image sampling and quantization, Basic relationship between pixels, Color image processing fundamentals related with all color Models, Types of Medical Images, Objectives of Biomedical Image Analysis, Computer aided Diagnosis, Image Quality and Information Content

UNIT II **[10 hours]**

Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing–Histogram equalization, Histogram matching (specification), Local enhancement, Arithmetic/Logic operations – Image subtraction, Image averaging, Basics of spatial filtering, Smoothing spatial filters – Smoothing linear filters, order statistics filters Sharpening spatial filters – Foundation, The Laplacian, The Gradient.

UNIT III **[07 hours]**

Image Enhancement in Frequency Domain: Background, Basic properties of the frequency domain, Basic filtering in the frequency domain, Basic filters and their properties, Smoothing frequency domain filters – Ideal low pass filters, Butterworth low pass filters, Gaussian low pass filters, Sharpening frequency domain filters – Ideal high pass filters, Butterworth high pass filters, Gaussian high pass filters, Homomorphic filtering.

UNIT IV **[7hours]**

Removal of Artifacts: Characterization of Artifacts, Image degradation/restoration model, Examples of noise PDFs, Structured noise Physiological interference, Other types of noise and artifact, Restoration using spatial filtering – Mean filters, Geometric mean filters, Harmonic mean filters, Median filter, Max & min filters, Midpoint filter.

UNIT V **[8 hours]**

Detection of Regions of Interest: Thresholding and Binarization, Optimal thresholding Detection of Isolated Points and Lines, Edge Detection, The Laplacian of Gaussian, , Region Growing, Splitting and merging of regions Image Compression: Fundamentals, Variable length coding, LZW coding, Bit plane coding, Run- length coding, Lossless predictive coding, Lossy predictive coding, Image compression standards – Basic, JPEG.

TEXT BOOKS:

1. Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc.
2. Biomedical Image Analysis by Rangaraj M Rangayan by CRC Press 2004

REFERENCE BOOKS:

1. Image Processing, Analysis and Machine-Vision by Milan Sonka, Vaclav Hlavac & Roger Boyle, Second Edition
2. Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University Press

E BOOKS

1. http://people.ucalgary.ca/~ranga/enel697
2. http://www.fields.utoronto.ca/

E-COURSE

1. scpd.stanford.edu
2. ocw.mit.edu

Course Title	BIO-MEDICAL SIGNAL PROCESSING	Course Code	16ML6DCBSP
Credits	03	L-T-P-S	2-0-1-0

Course Outcomes

CO1. Ability to apply knowledge of mathematics, science and engineering to develop solutions using biomedical signal processing concepts
CO2. Ability to analyze a problem and formulate appropriate solution for biomedical signal processing concepts and applications
CO3. An ability to design experiments in biomedical signal and analyze computer based process to meet desired needs in healthcare.
CO4. Ability to work, document and present as an individual and as a team-member to design formulate and implement experiments using modern tools.
CO5. Implement the concepts practically in groups, perform an open ended experiment/mini-project. Present and document the same.

UNIT I **[6 hours]**

Adaptive filters: Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 50 Hz and power line interference in electrocardiography, applications of adaptive filters. Canceling Donor heart Adaptive filters, high frequency noise in ECG, motion artifact in ECG, maternal interference in Fetal ECG, canceling of maternal ECG in fetal ECG, muscle contraction interference in VAG, interference in Heart-transplant electrocardiography, cancellation of ECG signal from the electrical activity of the chest muscles, cancellation of high frequency noise in Electro-surgery.

UNIT II **[5 hours]**

Data Compression Techniques: Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, FAN coding techniques.

UNIT III **[5 hours]**

Cardiological Signal Processing: ECG Parameters and their estimations: ECG QRS Detection techniques, estimation of R-R interval, estimation of ST segment inclination, Rhythm analysis, arrhythmia analysis monitoring, long term continuous ECG recording.

UNIT IV **[5 hours]**

Neurological signal processing: Introduction, Linear prediction theory, The Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, EEG Transient detection and elimination in epileptic patients and its overall performance.

UNIT V **[5 hours]**

Sleep EEG: Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modeling sleep.

TEXTBOOKS:

1. D.C.Reddy, Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill, 2005

2. Rangaraj M. Rangayyan – Biomedical Signal Analysis. IEEE Press, 2001.

REFERENCE BOOKS:

1. Biomedical Digital Signal Processing, Willis J.Tompkins, PHI,
2. Akay M , Biomedical Signal Processing, Academic: Press 1994

E-Books:

1. www.crcpress.com › Biomedical Science › Biomedical Imaging
2. downloads.hindawi.com/journals/special issues/129194.pdf

Online course

1. ocw.mit.edu › Courses › Health Sciences and Technology MIT Open Course War
   http://ocw.mit.edu
2. www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images

Credits	03	L-T-P-S	2-1-0-0

Course Outcomes

CO1.

CO2. Ability to apply knowledge of mathematics, science and engineering to understand the features of biomaterials and the biocompatibility phenomena.

CO3. Ability to understand the function and relationship between the structure and functionality of chosen artificial organ

CO4. Ability to comprehend an application of membrane materials in artificial organs and implants

CO5. Ability to analyze technical, ethical, economic, environmental and legal problems and formulate appropriate solution.

UNIT I **[5 hours]**

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY Definition and classification of bio-materials, mechanical properties, visco-elasticity, woundhealing process, body response to implants, blood compatibility

UNIT II **[6 hours]**

IMPLANT MATERIALS Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications

UNIT III **[5 hours]**

POLYMERIC IMPLANT MATERIALS Polymerization, polyamides, Acryrilic polymers, rubbers, high strength thermoplastics, medical applications. Bio polymers: Collagen and Elastin.

UNIT IV **[5 hours]**

TISSUE REPLACEMENT IMPLANTS Soft-tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

UNIT V **[5 hours]**

ARTIFICIAL ORGANS Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenateor), Artificial Kidney (Dialyser membrane) , Dental Implants – Artificial limb & hand. Ethical, Environmental and Safety issues in the implantation of artificial organs.

TEXT BOOKS

1. Sujata V. Bhatt, Biomaterials Second Edition, Narosa Publishing House,2005.
2. Joon B.Park Joseph D. Bronzino, Biomaterials - Principles and Applications – CRC Press, 2003

REFERENCE BOOKS

1. Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 1984.
2. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003

E-BOOKS:

1. **https://www.amazon.com/Biomaterials-Artificial-Engineering-Woodhead-Publishing-ebook/dp/B00QQ6B83U**
2. **medind.nic.in/taa/t05/i2/taat05i2p148.pdf**

MOOC Courses:

1. **http://ocw.mit.edu/courses/biological-engineering/20-441j-biomaterials-tissue-interactions-fall-2009/**
2. **http://oyc.yale.edu/biomedical-engineering/beng-100/lecture-25**

Course Title	MEDICAL DEVICE DEVELOPMENT	Course Code	16ML6DCMDD
Credits	06	L-T-P-S	3-0-1-2

Course Outcomes

CO1. Identify and analyse unmet clinical need and its requirements to solve it.
CO2. Search, analyse and document clinical practice, engineering science and relevant literature in order to determine the need for further research and development in a chosen clinical area.
CO3. Develop a sustainable business plan, including market overview, regulation strategies for health & safety of individuals and intellectual property (IP) strategies.
CO4. Understand medical device design engineering and manufacturing process by avoiding common quality pitfalls in turn learning project management.
CO5. Present the findings of the research in a team to peer audience.

UNIT I **[10 hours]**

MedTech Invention: Needs finding through Observation and Problem Identification. Need Statement Development. Need Screening & Selection through Stakeholder Analysis, Market Analysis & Needs Filtering. Concept Generation, Screening and selection

UNIT II **[8 hours]**

Product Requirements: Define MedTech Device. Classification of Device. Role of Requirements in MedTech Product Development. Market Requirements, Customer Requirements, Clinical Workflow. Design Input. ISO 13485. Intended use, Functional / performance requirements, safety, usability requirements etc

UNIT III **[8 hours]**

Design Engineering: Design and Development Plan. Design Process. Design Outputs, Intermediate deliverables - System Architecture, Subsystem requirements, Prototype, System Integration. Design Review. Design Verification

UNIT IV **[7 hours]**

Validation: System Validation. Usability Validation. Safety Validation. Clinical Validation, Regulatory Submission

UNIT V **[6 hours]**

Program Management: Program Planning, Stage Gate Process, Milestones. Budgeting, Development Strategy, Risk identification and Mitigation process

Text Books:

1. **"Biodesign: The Process of Innovating Medical Technologies**", by Stefanos Zenios , Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel published by **Cambridge University Press; 2nd edition**

Reference Books:

1. **"Inventing medical devices: A perspective from India",** by Dr Jagdish Chaturvedi, CreateSpace Independent Publishing Platform; 1st edition, 2015.
2. **"The Medical Device R&D Handbook",** by Theodore R. Kucklick, Second Edition, CRC Press, 2012.

EBOOKS:

1. https://generisgp.files.wordpress.com/2016/05/ebook-medical-device-development-best-practices.pdf
2. http://www.propelmg.com/edenbiodesign/ebook/eden-ten/files/eden-biodesign-celebrating-ten-years.pdf

ONLINE COURSES:

1. http://biodesign.stanford.edu/programs/stanford-courses.html
2. http://medicaldevicecourses.com/2015/03/medical-device-development/

Course Title	MEDICAL IMAGING MODALITIES	Course Code	16ML6DCMIM
Credits	04	L-T-P-S	3-1-0-0

Course Outcomes

CO1: Ability to apply knowledge of mathematics, science and engineering to develop solutions using Medical imaging concepts

CO2: Ability to analyze a problem and formulate appropriate solution for medical imaging applications.

CO3: Ability to work, document and present as an individual and as a team-member to understand the medical imaging modalities through hospital visit

CO4: Ability to engage in through virtual platform explore computing requirements for medical data

UNIT I **[9 hours]**

Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Biological effects of ionizing radiation, Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Image subtraction Computed Tomography: Conventional tomography, Computed tomography – Projection function, Algorithms for image reconstruction, CT number, Image artifacts, Spiral CT. Recent developments, Digital radiography, Digital subtraction angiography (DSA)

UNIT II **[7 hours]**

Fundamentals of acoustic propagation - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers.

Ultrasonic diagnostic Methods: Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), Doppler methods, Biological effects of ultrasound.

UNIT III **[9 hours]**

Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, diagnostic methods using radiation detector probes – Thyroid function test, Renal function test, Blood volume measurement, SPECT,PET**.**

UNIT IV **[8 hours]**

Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

UNIT V **[7 hours]**

Introduction, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, introduction to Functional MRI**.**

Text books

1. Principles of Medical Imaging by Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.
2. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.

Reference Books:

1. Fundamentals of Medical Imaging by Paul Suetens, Cambridge University Press, 2002.
2. Medical imaging signals and systems M. Links. Upper Saddle River, NJ: Pearson Prentice Hall, 2006.

E-books:

1. http://link.springer.com/chapter/10.1007%2F978-3-540-68993-5_10
2. http://ebooks.cambridge.org/ebook.jsf?bid=CBO9780511596803

MOOC Courses

1. https://www.edx.org/course/introduction-biomedical-imaging-uqx-bioimg101x-2
2. https://www.mooc-list.com/bioimg101x-introduction-biomedical-imaging-edx

CLUSTER ELECTIVE-I

Course Title	BIO-MEMS	Course Code	16ML6GE1BM
Credits	03	L-T-P-S	3-0-0-0

Course Outcomes

CO1 Ability to apply knowledge of mathematics, science and engineering to understand the working principle of MEMS and sensors, Microfluidic Systems, Bio-mems
CO2 Ability to identify, analyse and formulate the computing requirement using MOEMS technology, Microfabrication techniques.
CO3 An ability to understand the environmental impact & safety issues of biomems with reference to medical standards and ethics.
CO4 Ability to function, engage in implementing, communicating the concepts and principles learnt in course using softtool

UNIT-I [7 **Hours]**

MEMS and Microsystems: Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modelling and properties of materials.

Micro sensors and Acuators: Mechanical sensors and actuators – beam and cantilever, Piezoelectric materials, thermal sensors and actuators- micro machined thermocouple probe, Peltier effect heat pumps, thermal flow sensors

UNIT-II **[9 Hours]**

Micro Opto Electro Mechanical Systems: Fundamental principle of MOEMS technology, light modulators, beam splitter, microlens, digital micromirror devices, light detectors, optical switch.

Microfluidic Systems: Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, electrophoresis, microfluid dispenser, microneedle, micropumps continuous flow system.

UNIT-III **[7 Hours]**

Scaling laws in miniaturization: Introduction to scaling, scaling in geometry, scaling in rigid body dynamics.

Microfabrication techniques: Introduction, photolithography, electron beam lithography, and soft lithography, chemical vapour deposition, Impurity doping, Etching, micromachining.

UNIT-IV [9 Hours]

Introduction to Bio-MEMS: what are biosensors? , the driving force behind biomedical applications, biocompatibility, reliability considerations, regulatory considerations, Emerging BioMEMs Technology: minimally invasive surgery, point care clinical diagnosis, pressure and flow measurement in cardiovascular system, diabetes, endoscopy, neurosciences, oncology, ophthalmology.

UNIT-V **[7 Hours]**

Chemical and biomedical micro systems:

Introduction, sensing mechanism , primary sensing principle, membrane transducer materials, Chem-lab-on-a-chip(CLOC), chemoresistors, chemocapacitors,chemotransistors, E-Nose, Mass sensitive chemo sensors, fluorescence detection, SAW sensors.

TEXT Books:

1. Nitaigour Premchand Mahalik, " MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007
2. Steven S. Saliterman, "Fundameantals of BioMEMS and Medical Microdevices", Wiley Interscience.

Reference Books:

1. Tai-Ran-Hsu, "MEMS and Microsystems design and manufacture" Tata McGraw Hill Publishing Company, NewDelhi, 2002
2. Vijay K Varadan, K J Vinoy, S Gopakrishnan, " Smart material systems and MEMS design and development methodologies", WILEY, India, 2006

E-Books:

1. https://www.crcpress.com/Bio-MEMS-Technologies-and-Applications/Wang-Soper/p/book/9780849335327
2. https://www.amazon.in/Bio-MEMS-Technologies-Applications-Wanjun-Wang-ebook/dp/B009AI34IS

MOOC Courses:

1. https://www.extension.harvard.edu/academics/courses/introduction-mems-biomems/14876
2. https://onlinecourses.nptel.ac.in/noc15_me01/preview

Course Title	ADVANCED MEDICAL IMAGE PROCESSING	Course Code	16ML6GE1IP
Credits	03	L-T-P-S	3-0-0-0

Course Outcomes

CO1: To apply knowledge of Mathematics and Engineering to use Morphological operations in image Processing.
CO2: An ability to identify and analyze a problem and formulate the computing requirements for segmentation of images
CO3: An ability to implement the processes to detect and recognize an object in the images.
CO4: To apply wavelet transform to compress and enhance the quality of images.
CO5: An ability to use current techniques and modern tools to improve the image analysis.

UNIT I **[9 hours]**

MORPHOLOGICAL IMAGE PROCESSING: Preliminaries, Erosion and Dilation, Duality, Opening and Closing, The Hit-or-Miss Transformation, Basic Morphological Algorithms: Boundary Extraction, Hole Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Morphological Reconstruction, Gray-Scale Morphology, Erosion and Dilation, Opening and Closing.

UNIT II **[8 hours]**

IMAGE SEGMENTATION: Fundamentals, Point, Line, and Edge Detection, Detection of Isolated Points, Edge Models, Edge Linking and Boundary Detection, Thresholding, Basic Global Thresholding, Optimum Global Thresholding using Otsu's Method. Region Based Segmentation, Region Growing, Region Splitting and Merging, Segmentation Using Morphological watersheds, watershed segmentation Algorithm.

UNIT III **[8 hours]**

REPRESENTATION AND DESCRIPTION: Representation of Boundary (Border), Chain Codes, Polygonal Approximations Using Minimum-Perimeter Polygons, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Shape Numbers, Fourier Descriptors, Statistical Moments, Regional Descriptors, Topological Descriptors, Texture, Moment Invariants, Use of Principal Components for Description.

UNIT IV **[6 hours]**

OBJECT RECOGNITION: Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods, Matching, Optimum Statistical Classifiers, Neural Networks, Structural Methods, Matching Shape Numbers, String Matching.

UNIT V **[8 hours]**

WAVELETS AND MULTIRESOLUTION PROCESSING: Image Pyramids, Sub band Coding, The Haar Transform, Multi resolution Expansions, Series Expansions, Scaling Functions, Wavelet Functions, Wavelet Transforms in One Dimension, The Wavelet Series Expansions, The

Discrete Wavelet Transform, The Continuous Wavelet Transform. The Fast Wavelet Transform. Wavelet Transforms in Two Dimensions. Wavelet Packets.

TEXT BOOK:

1. Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc.
2. Image Processing, Analysis and Machine-Vision by Milan Sonka, Vaclav Hlavac & Roger Boyle, Second Edition

REFERENCES:

1. Digital Image Processing using MATLAB by Rafael. Gonzalez & Richard E. Woods, Second Edition. Pearson Education Inc.
2. Digital Image Processing by S Jayakumaran, S Esakkirajan, T Veerakumar, Tata McGraw Hill Education Private Ltd,.

E-BOOKS:

1. http://www.sciencedirect.com/science/book/9780123739049
2. http://www.springer.com/us/book/9781441997692

MOOC Courses:

1. https://cs.uwaterloo.ca/~jorchard/cs473/CS473/Welcome.html
2. https://spie.org/education/online-courses-and-dvds/online-course-detail?course_id=P0843553