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

<table>
<thead>
<tr>
<th>PEO</th>
<th>Description</th>
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<tbody>
<tr>
<td>PEO1</td>
<td>Graduates will make a successful career in the field of healthcare and allied engineering fields.</td>
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<tr>
<td>PEO2</td>
<td>Graduates will demonstrate the ability to work as a member of a professional team with effective communication skills and function as a responsible individual.</td>
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<tr>
<td>PEO3</td>
<td>Graduates will use undergraduate foundation to pursue higher studies, research and will participate in life-long learning throughout their careers</td>
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Program Outcomes

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

Abbreviated Course Title (in three letters)
  - Core (C)
  - Elective (E)
  - Mandatory (M)
  - Laboratory (L)

Course Type
  - Core (C)
  - Elective (E)
  - Mandatory (M)
  - Laboratory (L)

Course offered for
  - Department (D)
  - Cluster (G)
  - Institution (I)

Course offered in Semester (Example: 1, 2, 3… 10)

DEPARTMENT/CLUSTER (Example: CV/ME/EE etc.)

YEAR OF COURSE INTRODUCTION
Program: **Medical Electronics**  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<td>1 6 M L 5 D C E S D</td>
<td>Embedded Systems Design</td>
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<td>03</td>
<td>50</td>
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<td>1 6 M L 5 D C B M I</td>
<td>Biomedical Instrumentation</td>
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**TOTAL**  

<p>| 16 3 2 4 | 25 300 300 600 |</p>
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<td>03 03</td>
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V SEMESTER
DEPARTMENT CORE
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
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
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
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
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
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
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]**


**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, De 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:**

**Reference Books:**
1. Leslie Cromwell, Fred J. Weibell, Eric A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI

**E-Books:**

**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
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]
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 prevention, 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

**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:**


**REFERENCE BOOKS:**

1. Biomechanics principles and applications by Schneck and Bronzino, CRC Press, 2003

**E-Books**

1. [https://booksfree4u.tk/download-biomechanics-ebook-pdf-free/](https://booksfree4u.tk/download-biomechanics-ebook-pdf-free/)

**Online-courses:**

2. [https://www.mooc-list.com/tags/biomechanics?static=true](https://www.mooc-list.com/tags/biomechanics?static=true)
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]


UNIT III [8 HOURS]


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]


TEXT BOOKS:


REFERENCE BOOKS:


E-books

1. The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.

MOOC Courses

1. https://www.coursera.org/course/dsp
Course Title: MEDICAL PHYSICS
Credits: 03
Course Code: 16ML5DCMDP

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]

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]

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, CO₂ 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:
2. Dr. R.N.Roy “Medical biophysics”, Books and Allied(P) Ltd. 1st Edition,2001,

REFERENCE BOOKS:
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:

MOOC Courses
2. http://www.medsci.ox.ac.uk/study/bms
DEPARTMENT ELECTIVE-I
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]

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.

Reference Books:

**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](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](http://hagan.okstate.edu/NNDesign.pdf))

**Online courses**

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


UNIT II  
[6 hours]
Structures and Unions, User defined data types.


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:

Reference Books:

E-Books:
1. www.dddegjust.ac.in/studymaterial/mca-3/ms-17.pdf

MOOC Courses:
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]


UNIT II [08 Hours]

Signal Processing for BCIs: 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

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


TEXT BOOKS:


[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:

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 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]

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 [7 hours]
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]
TEXT BOOKS:

2. Biomedical Image Analysis by Rangaraj M Rangayan by CRC Press 2004

REFERENCE BOOKS:


E BOOKS

1. http://people.ucalgary.ca/~ranga/enel697

E-COURSE

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


UNIT IV [5 hours]


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:


REFERENCE BOOKS:

1. Biomedical Digital Signal Processing, Willis J. Tompkins, PHI,

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]
Course Outcomes

CO1. Ability to apply knowledge of mathematics, science and engineering to understand the features of biomaterials and the biocompatibility phenomena.

CO2. Ability to understand the function and relationship between the structure and functionality of chosen artificial organ

CO3. 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, Acrylic 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 (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants – Artificial limb & hand. Ethical, Environmental and Safety issues in the implantation of artificial organs

TEXT BOOKS

REFERENCE BOOKS

E-BOOKS:
2. medind.nic.in/taa/t05/i2/taat05i2p148.pdf

MOOC Courses:
2. http://oyc.yale.edu/biomedical-engineering/beng-100/lecture-25
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]

UNIT II [8 hours]

UNIT III [8 hours]

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:

Reference Books:
EBOOKS:


ONLINE COURSES:

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]


**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]


**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**


**Reference Books:**


**E-books:**


**MOOC Courses**

1. [https://www.edx.org/course/introduction-biomedical-imaging-uqx-bioimg101x-2](https://www.edx.org/course/introduction-biomedical-imaging-uqx-bioimg101x-2)

2. [https://www.mooc-list.com/bioimg101x-introduction-biomedical-imaging-edx](https://www.mooc-list.com/bioimg101x-introduction-biomedical-imaging-edx)
CLUSTER ELECTIVE-I
**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**

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

**Micro sensors and Actuators:** 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**

**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**

**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**

**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**

**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:

Reference Books:
2. Vijay K Varadan, K J Vinoy, S Gopakrishnan, “Smart material systems and MEMS design and development methodologies”, WILEY, India, 2006

E-Books:

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**

**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**

**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**

**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**

**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**

**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

**TEXT BOOK:**


**REFERENCES:**


**E-BOOKS:**


**MOOC Courses:**

1. [https://cs.uwaterloo.ca/~jorchard/cs473/CS473/Welcome.html](https://cs.uwaterloo.ca/~jorchard/cs473/CS473/Welcome.html)

2. [https://spie.org/education/online-courses-and-dvds/online-course-detail?course_id=P0843553](https://spie.org/education/online-courses-and-dvds/online-course-detail?course_id=P0843553)