## VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION - 2014
#### M.Tech.- BIOMEDICAL SIGNAL PROCESSING & INSTRUMENTATION

### I SEMESTER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Teaching Hours/week</th>
<th>Duration of Exam (Hours)</th>
<th>Marks for</th>
<th>Total Marks</th>
<th>Credits</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical / Field Work / Assignment / Tutorials</td>
<td>L.A.</td>
<td>Exam</td>
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<tr>
<td>14LBI11</td>
<td>Physiology for Biomedical Engineering</td>
<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>14LBI12</td>
<td>Medical Instrumentation</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14LBI13</td>
<td>Advanced Biomedical Signal Processing</td>
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<td>2</td>
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<tr>
<td>14LBI14</td>
<td>Real Time Signal Processing</td>
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<td>2</td>
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<tr>
<td>14LBI15X</td>
<td>Elective-I</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14LBI16</td>
<td>Biomedical Signal Processing and Instrumentation Lab</td>
<td>-</td>
<td>3</td>
<td>25</td>
<td>50</td>
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<tr>
<td>14LBI17</td>
<td>Seminar</td>
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### ELECTIVE – I

<table>
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<tbody>
<tr>
<td>14LBI151</td>
<td>Linear Algebra and Applications</td>
</tr>
<tr>
<td>14LBI152</td>
<td>ARM Embedded System Design</td>
</tr>
<tr>
<td>14LBI153</td>
<td>Biomaterials &amp; Artificial Organs</td>
</tr>
<tr>
<td>14LBI154</td>
<td>Optical Coherence Tomography</td>
</tr>
<tr>
<td>14LBI155</td>
<td>Lasers in Medicines</td>
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## II SEMESTER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Hours/week</th>
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<td>Lecture</td>
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<td>Duration of Exam (Hours)</td>
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<tr>
<td>14LBI21</td>
<td>Neural Networks &amp; Fuzzy Logic in Medicine</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14LBI22</td>
<td>Medical Imaging Systems and Techniques</td>
<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>14LBI23</td>
<td>Advanced Medical Image Processing</td>
<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>14LBI24</td>
<td>Speech Signal Processing</td>
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<td>2</td>
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<td>14LBI25X</td>
<td>Elective-II</td>
<td>4</td>
<td>2</td>
<td>3</td>
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<tr>
<td>14LBI26</td>
<td>Speech and Image Processing Lab</td>
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<tr>
<td>14LBI27</td>
<td>Seminar</td>
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**Between the II Semester and III Semester, after availing a vacation of 2 weeks.**

**ELECTIVE – II**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>14LBI251</td>
<td>Health Care and Hospital Management</td>
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<tr>
<td>14LBI252</td>
<td>Virtual Bio-Instrumentation</td>
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<tr>
<td>14LBI253</td>
<td>Biosensors</td>
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<tr>
<td>14LBI254</td>
<td>Bioinformatics and Applications</td>
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<tr>
<td>14LBI255</td>
<td>Medical device regulation, Ethics and IPR</td>
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### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

**SCHEME OF TEACHING AND EXAMINATION - 2014**

M.Tech.- BIOMEDICAL SIGNAL PROCESSING & INSTRUMENTATION

**III SEMESTER: INTERNSHIP #**

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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<th>Marks for Total Marks</th>
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<tr>
<td>14LBI31</td>
<td>Seminar / Presentation on Internship (After 8 weeks from the date of commencement)</td>
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<tr>
<td>14LBI32</td>
<td>Report on Internship</td>
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<td>15</td>
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<tr>
<td>14LBI33</td>
<td>Evaluation and Viva-voce</td>
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* The student shall make a midterm presentation of the activities undertaken during the first 8 weeks of internship to a panel comprising Internship Guide, a senior faculty from the department and Head of the Department.

# The College shall facilitate and monitor the student internship program.

The internship report of each student shall be submitted to the University.
### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

**SCHEME OF TEACHING AND EXAMINATION - 2014**

**M.Tech.- BIOMEDICAL SIGNAL PROCESSING & INSTRUMENTATION**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
<th>No of Hrs/Week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for</th>
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<tr>
<td>14LBI41</td>
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<td>14LBI43</td>
<td>Evaluation of Project Phase II</td>
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<tr>
<td>14LBI44</td>
<td>Evaluation of Project Phase III</td>
<td>--</td>
<td>--</td>
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<tr>
<td>14LBI45</td>
<td>Evaluation of Project work and Viva-voce</td>
<td>--</td>
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**ELECTIVE – III**

<table>
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<tr>
<th>Course Code</th>
<th>Subject</th>
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<tbody>
<tr>
<td>14LBI421</td>
<td>Biostatistics</td>
</tr>
<tr>
<td>14LBI422</td>
<td>Biomechanics and Rehabilitation Engineering</td>
</tr>
<tr>
<td>14LBI423</td>
<td>Wavelets in Biomedical Engineering</td>
</tr>
<tr>
<td>14LBI424</td>
<td>Modelling and Simulation in Biomedical Engineering</td>
</tr>
<tr>
<td>14LBI425</td>
<td>Artificial Intelligence and Pattern Recognition</td>
</tr>
</tbody>
</table>

**Note:**

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalise the topic of dissertation.

2) Project Phase – II: 16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.


**Marks of Evaluation of Project:**
- The I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:
   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (out of two external examiners at least one should be present).
PHYSIOLOGY FOR BIOMEDICAL ENGINEERING

Subject Code: 14LBI11  
Hrs/Week: 04  
Total No. of Lecture Hours: 50  
IA Marks: 50  
Exam Marks: 100  
Exam hours: 03

General Physiology: Cell, Cell junctions, Transport through cell membrane, Homeostasis, Acid base balance.

Respiratory System & Environmental Physiology: Physiological anatomy of respiratory tract, Pulmonary circulation, Mechanics of respiration, Pulmonary function tests, Ventilation, Exchange of respiratory gases, Transport of respiratory gases, Regulation of respiration, Artificial respiration.

Renal Physiology: Kidney, Nephron, Juxtaglomerular apparatus, Renal circulation, Urine formation, Concentration of urine, Acidification of urine, Renal function tests, Renal disorders, Micturition, Uro flow studies, Dialysis.

Cardiovascular System: Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle, Heart sounds, Cardiac murmurs, Electrocardiogram, Vector, Arrhythmia, Cardiac output, Regulation of heart rate, Hemodynamics, Arterial blood pressure, Hemorrhage.

GIS: GIS, Functions of stomach, pancreas, liver, intestine, function tests: endoscopies.

Nervous System: Introduction to nervous system, Neuron, Classification of nerve fibers, Properties of nerve fibers, Degeneration & regeneration of nerve fibers, Neuroglia, Receptors, Synapse, Neurotransmitters, Reflex activity, Physiology of pain, Hypothalamus, Electroencephalogram,

Physiology of sleep, Epilepsy, cerebrospinal fluid, Autonomic nervous system and ANS tests. Evoked potentials. Cerebral circulation and tests.

Muscle Physiology: Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction, Electromyogram & disorders of skeletal muscles

Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.


REFERENCE BOOKS:

MEDICAL INSTRUMENTATION

Subject Code : 14LBI12  IA Marks: 50
Hrs/Week: 04  Exam Marks : 100
Total No. of Lecture Hours : 50  Exam hours : 03

Bioelectric Signals and Electrodes : Sources of biomedical signals, basic medical instrumentation system, PC based medical instruments, General constraints in design of medical instrumentation systems, origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electoretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes. Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

Biomedical Recording Systems & Recorders : Electrocardiograph-block diagram, ECG leads, effects of artifacts, multi-channel, ECG machine, Phonocardiograph-origin of heart sounds, microphones and amplifiers for PCG, Electroencephalograph- block diagram, computerized analysis of EEG, Electromyograph, biofeedback instrumentation.


REFERENCE BOOKS:
ADVANCED BIOMEDICAL SIGNAL PROCESSING

Subject Code : 14LBI13  IA Marks: 50
Hrs/Week: 04  Exam Marks : 100
Total No. of Lecture Hours : 50  Exam hours : 03

Introduction: General measurement and diagnostic system, classification of signals, introduction to biomedical signals, Biomedical signal acquisition and processing, Difficulties in signal acquisition.

ECG: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis, Arrhythmia, Arrhythmia analysis, Arrhythmia monitoring system.

ECG Data Reduction: Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loève Transform, Other data compression Techniques: DPCM, Huffman coding, Data compression Techniques comparison.

Signal averaging: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging.

Frequency Domain Analysis: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG.


Event Detection and waveform analysis: Need for event detection, Detection of events & waves, Correlation analysis of EEG signals, The matched filter, Detection of the P wave, Identification of heart sounds, Morphological analysis of ECG waves, analysis of activity.

Adaptive Filtering: Introduction, General structure of adaptive filters, LMS adaptive filter, adaptive noise cancellation, Cancellation of 60 Hz interference in ECG, cancellation of ECG from EMG signal, Cancellation of maternal ECG in fetal ECG.

EEG: EEG signal characteristics, Sleep EEG classification and epilepsy.

REFERENCE BOOKS:
REAL TIME SIGNAL PROCESSING

Subject Code : 14LBI14
IA Marks: 50
Hrs/Week: 04
Exam Marks : 100
Total No. of Lecture Hours : 50
Exam hours : 03

Introduction to Discrete Fourier Transform (DFT) and its relationship with other transforms. 10 Hrs
DFT properties.
Introduction to programmable system on chip (PSoC): PSoC Technology, Programmable Routing and Interconnect, Configurable Analog and Digital Blocks, CPU Sub system, Families of PSoC (PSoC 1, PSoC 3, PSoC 5), Difference between PSoC and conventional MCU.

Direct computation of DFT, Need for efficient computation of DFT (FFT Algorithms). 10 Hrs
Radix-2 FFT algorithm for the computation of DFT and IDFT – decimation in time and decimation in frequency algorithms.
Real Time Transforms: Discrete Cosine Transform, Walsh Transform, Hadamard Transform.

IIR Filter Design: Design of IIR filters from analog filters (Butterworth and Chebyshev). 10 Hrs
Impulse invariance method, and bilinear transformation methods. Verification for stability and linearity during mapping.
Introduction to PSoC 3/5, PSoC 3/5 Architecture – Block Diagram, System Wide Resources, I/O Interfaces, CPU Subsystem, Memory Organization, Digital Subsystems, Analog Subsystems

Implementation of discrete time systems: Structures for IIR and FIR systems -Direct form I, 10 Hrs
Form-II, Cascade and parallel realizations.
Multirate Signal Processing: Concepts of multirate signal processing, Software implementation of sampling rate converters - decimators and interpolators, Sample rate conversion using polyphase filter structure.

Introduction to FIR filters, Design of FIR filters using Hamming, Rectangular, Barlet window method, FIR filter design using frequency mapping method. 10 Hrs

Reference Books:
LINEAR ALGEBRA & APPLICATIONS

Subject Code : 12LBI151 IA Marks : 50
No of Lecture Hrs/Week : 04 Exam Marks : 100
Total No. of Lecture Hours : 50 Exam hours : 03

Linear Equations: System of linear equations, Row reduction and echelon forms, Vector equations, Matrix equations, Solution sets of linear systems; Applications of Linear systems, matrix operations; inverse of a matrix, Matrix factorization, Applications to computer graphics.

10 Hrs

Vector Spaces: Vector spaces and subspaces; Linearly independent sets; bases, coordinate systems, dimension of a vector space; Rank, Change of basis Applications to difference equations.

10 Hrs

Linear Transformations: Linear transformations; eigen vectors and eigen values, characteristic equation, diagonalization, eigen vectors and linear transformation, Complex eigen values, Applications to differential equations.

10 Hrs

Orthogonality and Least Squares: Inner products, length and orthogonality, orthogonal sets, orthogonal projections; Gram-Schmidt process; QR-factorization; least-squares problems; Inner products spaces, Application to linear models, Application of inner product spaces.

10 Hrs

Symmetric Matrices and Quadratic Forms: Digitalization of symmetric matrices; quadratic forms; constrained optimization; singular value decomposition, Application to image processing and statistics.

10 Hrs

REFERENCE BOOKS:
ARM EMBEDDED SYSTEM DESIGN

Subject Code : 14LBI152  IA Marks: 50
Hrs/Week: 04  Exam Marks : 100
Total No. of Lecture Hours : 50  Exam hours : 03

Introduction To Embedded systems  10 Hrs
Introduction, Processor embedded into a system, embedded hardware units and devices in a system, examples, SOC and use of VLSI, Complex systems design, formalization of system design, classification of embedded systems, skills required for an embedded system designer, processor and memory organization.

ARM Embedded Systems and ARM processor fundamentals  10 Hrs
The RISC Design philosophy, The ARM Design philosophy, Embedded system hardware, Registers, Current program status register, pipeline, exceptions, interrupts and Vector table, Core extensions, Architecture revisions, ARM processor families.

Introduction to ARM instruction set and Data processing instructions, branch instructions, load-store instructions, software interrupts instruction, Program status register instructions, loading constants, ARMv5E extensions, conditional execution  10 Hrs

Introduction to the thumb instruction set and Exception and interrupt handling  10 Hrs
Thumb register usage, ARM-Thumb interworking, data processing instructions, Single & multiple-register Load-store instruction, stack instructions, software interrupt instruction, Exception handling, interrupts, interrupt handling schemes

Embedded operating systems and Future of the Architecture  10 Hrs
Fundamental components, Example: Simple little operating system. Advanced DSP and SIMD support in ARMv6, System and multiprocessor support additions to ARMv6, Armv6 implementations, Future technologies beyond ARMv6

Reference Books:
BIOMATERIALS AND ARTIFICIAL ORGANS

Subject Code : 14LBI153  IA Marks: 50
Hrs/Week: 04  Exam Marks : 100
Total No. of Lecture Hours : 50  Exam hours : 03

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY 10 Hrs
Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound-healing process, body response to implants, blood compatibility

IMPLANT MATERIALS 10 Hrs
Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications

POLYMERIC IMPLANT MATERIALS 10 Hrs

TISSUE REPLACEMENT IMPLANTS 10 Hrs
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.

ARTIFICIAL ORGANS 10 Hrs
Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenateor), Artificial Kidney (Dialyser membrane), Dental Implants – Artificial limb & hand

REFERENCE BOOKS:
OPTICAL COHERENCE TOMOGRAPHY

Subject Code : 12LBI154  IA Marks : 50
No of Lecture Hrs/Week : 04  Exam hours : 03
Total No. of Lecture Hours : 50  Exam Marks : 100

Optical sources, optical delay scanning, system integration and signal/image processing, Speckle reduction techniques, Doppler optical coherence microscopy. Spectral radar, optical coherence tomography (OCT) in Fourier domain, OCT for high density data storage, OCT for study of polymer components, OCT in laryngology, urology, gynecology, Gastrointestinal applications, cardiology, cardiology, study of eye

REFERENCE BOOKS:

3. “Optical Coherence Tomography and Coherent, European Conference on Biomedical Optics”, Wolfgang Drexler(Editor), Optical Coherence Tomography and Coherence Techniques”
LASERS IN MEDICINE

Subject Code : 14LBI155
IA Marks: 50
Hrs/Week: 04
Exam Marks : 100
Total No. of Lecture Hours : 50
Exam hours : 03

Basics of Lasers: Principle of operation of laser, Characteristics of stabilization, Q-switching and mode locking, frequency stabilization, Line shape function, lasing threshold, major types of lasers, construction of Ruby, He-Ne, Nd-YAG, semiconductor, Argon and Carbon dioxide lasers. safety with lasers, basics of fiber optics.

10 Hrs


10 Hrs

Physics of Ultraviolet Laser Ablation: Decomposition of UV radiation in organic materials, target decomposition, ablation plume, repetitive irradiation.

10 Hrs


10 Hrs

Therapeutic and Diagnostic Application of Laser in Ophthalmology: Transmission and absorptive properties of ocular tissues, photo thermal laser application, photo disruptive laser application, photochemical laser application, diagnostic laser applications

10 Hrs

Case Studies: LASIK, Laser interstitial thermal therapy (LITT), Lithotripsy, photo bleaching, PHOTOFRIN photodynamic therapy in head and neck cancer, surgical application of laser in cardiology

10 Hrs

REFERENCE BOOKS:


BIOMEDICAL SIGNAL PROCESSING & INSTRUMENTATION LAB

Subject Code : 14LBI16  
Hrs/Week: 03  
Total No. of Lecture Hours : 42  
IA Marks: 25  
Exam Marks : 100  
Exam hours : 03

Laboratory Experiments:
1. Acquisition of Electrocardiogram and determining the cardiac vector.
2. Acquisition of Electromyogram and determining conduction velocity.
3. Study of Audiometer and Air conduction thresholds testing; Plotting of Audiogram.
4. Study of Blood Pressure meter and Phonocardiograph.
5. Design and implementation of circuits with biomedical applications (like QRS detector, ECG Amplifier, EMG.....etc)
7. Spectral Modeling and Analysis of ECG Signals
8. Detection of QRS complex and heart rate measurement.
9. Auto-correlation and cross correlation of ECG signals.
10. Signal Averaging to improve the SNR.
11. Design of 50 Hz notch filter for ECG signal and display PSD.
NEURAL NETWORK & FUZZY LOGIC IN MEDICINE

Subject Code: 14LBI21  IA Marks: 50
Hrs/Week: 04  Exam Marks: 100
Total No. of Lecture Hours: 50  Exam hours: 03

Learning and Soft Computing: Examples, basic tools of soft computing, basic mathematics of soft computing, Differences between neural network and Biological neural network, Network Architecture, Artificial Intelligent

Learning process: Error correction Algorithm, Memory based Learning, Hebian Learning, Learning with Teacher, Learning without Teacher

Single Layer Networks: Perception, Perceptron Convergence theorem, Realization of Basic logic gates using single layer Perceptron, Adaptive linear neuron (Adaline) and the LMS algorithm.

Multilayer Perception: Error back propagation algorithm, generalized delta rule, XOR Problem, Practical Aspects of Error Back Propagation Algorithm, Problems

Radial Basis Function Networks: Ill Posed Problems And Regularization Technique, Stabilizers and Basis Functions, Generalized Radial Basis Function Networks.

Support Vector Machines: Risk minimization principles and the Concept of Uniform Convergence, VC dimension, Structural Risk Minimization, support vector machine algorithms


Fuzzy Rule based system: Linguistic Hedges, Rule based system, Graphical techniques for Inference, Fuzification and Difuzifications, fuzzy additive models.

Case studies: Fuzzy logic control of Blood pressure during Anesthesia, Fuzzy logic application to Image processing equipment, Adaptive fuzzy system. Introduction to Neuro-fuzzy logic tool using Mat lab

REFERENCE BOOKS:
5. Bart Kosko, “Neural Networks and Fuzzy Systems” prentice Hall of India, 2005
MEDICAL IMAGING TECHNIQUES & SYSTEMS

Introduction: Basic imaging principle, Imaging modalities-Projection radiography, Computed Tomography, Nuclear medicine, Ultrasound imaging, Magnetic Resonance Imaging.


Ultrasound: Acoustic propagation, Attenuation, Absorption and Scattering, Ultrasonic transducers, Transducer Arrays, A mode, B mode, M mode scanners, Tissue characterization, Color Doppler flow imaging, Echocardiography.

Radio Nuclide Imaging: Interaction of nuclear particles and matter, Nuclear sources, Radionuclide generators, Nuclear radiation detectors, Rectilinear scanner, scintillation camera, SPECT, PET.

INFRA RED IMAGING: Physics of thermography – imaging systems – pyroelectric vidicon camera clinical thermography

Magnetic Resonance Imaging: Angular momentum, Magnetic dipole moment, Magnetization, Larmor frequency, Rotating frame of reference, Free induction decay, Relaxation times, Pulse sequences, Generation and Detection of NMR Imager. Slice selection, Frequency encoding, Phase encoding, Spin-Echo imaging, Gradient-Echo imaging, Imaging safety, Biological effects of magnetic field, Introduction to Functional MRI.

REFERENCE BOOKS:
1. “Principles of Medical Imaging”, K Kirk Shung, Michael B Smith & Benjamim M W Tsui,
ADVANCED MEDICAL IMAGE PROCESSING

Subject Code : : 14LBI23
Hrs/Week: 04
Total No. of Lecture Hours :  50
IA Marks: 50
Exam Marks : 100
Exam hours : 03

Fundamentals: Introduction, Fundamental steps in DIP, A simple image formation model, representing digital images, Spatial & Gray level resolution, Basic relationship between pixels.

Image Enhancement: Point operations, Spatial averaging, Median filtering, Spatial low pass, high pass and band pass filtering, Histogram equalization, Transform operations.

Image Compression: Huffman coding, DFT, DCT, Wavelet coding & JPEG standard.

Image segmentation: Detection of discontinuities, Edge linking and Boundary detection by local processing & global processing using Hough transform, Region based segmentation

Image Representation and Description: Representation – Chain codes, polygonal approximations, signatures, boundary segments, skeletons, Boundary descriptors – Some simple descriptors, Shape numbers, Fourier descriptors, statistical moments, Regional descriptors – Some simple descriptors, topological descriptors, texture.

Color Image Processing: Color fundamentals, Color models, Pseudo color image processing, Basics of full color image processing, Color transformations- Formulation, complements, histogram processing, Color image smoothing and sharpening, Color image segmentation

Morphological Image Processing: Basic concepts of set theory, Logical operations involving binary images, Dilation and erosion, Opening and closing, The hit-or-miss transformation, Basic morphological algorithms.

Motion Analysis: Introduction, Optical flow – Optical flow computation, Global and local optical flow estimation, optical flow computation approaches, optical flow in motion analysis

REFERENCE BOOKS:
SPEECH SIGNAL PROCESSING

Subject Code : 14LBI24
Hrs/Week: 04
Total No. of Lecture Hours : 50

IA Marks: 50
Exam Marks : 100
Exam hours : 03


Time Domain Models for Speech Processing: Time dependent processing of speech, Short time Energy and average magnitude, Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing.

Time Domain Models for Speech Processing: Pitch period estimation using parallel processing approach, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function.

Short Time Fourier Analysis: Introduction, Definitions and properties, Fourier transform interpretation, Linear filtering interpretation.


Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Applications of LPC parameters.

Speech Synthesis: Principles of Speech synthesis, Synthesis based on waveform coding, Synthesis based on analysis synthesis method, Synthesis based on speech production mechanism, Synthesis by rule, Text to speech conversion.


REFERENCE BOOKS:
INTRODUCTION TO HEALTH CARE MANAGEMENT

MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR

INFORMATION TECHNOLOGY AND STRATEGIC PLANNING
Information Technology: Information system used by Manager-Electronic Medical Record (EMR) - Challenges to Clinical system: Adoption-Future of Healthcare Information Technology on Healthcare manager-Strategic Planning: Planning process- SWOT Analysis-Strategy identification and selection- Rollout and implementation-Strategy execution

HOSPITAL MANAGEMENT
Evolution and classification of hospital: Classification of hospital-According to directory of hospital-According to ownership and control- According to system of medicine- According to bed strength-According to clinical basis- Hospital as system: Definition of system-Function of hospital-hospital organization- Role of hospital as primary health care- Evolution of hospital administration-Medical staff and hospital organization- Professional service department in hospital organization.

MANAGEMENT OF HOSPITAL MATERIALS AND MEDICAL RECORDS

REFERENCE BOOKS:
VIRTUAL BIO-INSTRUMENTATION

Subject Code : 12LBI252 IA Marks : 50
No of Lecture Hrs/Week : 04 Exam hours : 03
Total No. of Lecture Hours : 50 Exam Marks : 100

Basic Concepts: Data Acquisition (DAQ) basics, Lab VIEW Basics, Bio Bench basics.
Biopotentials: Typical Laboratory Workstation, Lab Layout and Design, Generic Instrumentation/ Data Acquisition Issues.
Electroneurology: Physiological basics, Experiment set up, Dissection, Nerve chamber preparation, generic VI Development, Experiment descriptions, Trouble shooting the nerve recording.
Neuromuscular Electrophysiology (Electromyography): Physiological basis, Experiment set up, Experiment descriptions, Trouble shooting the nerve – Muscle Preparation.
Cardiac Electrophysiology (Electrocardiology): Physiological basis, Experiment descriptions.
Cardiopulmonary Dynamics: Typical Laboratory Workstation, Generic Instrumentation/Data Acquisition Issues.
Pulmonary Function: Physiological Basis, Experiment setup, Pulmonary DAQ system operation.
Lung Tissue Viscoelastance: Experiment setup, Experiment Description.
Cardiovascular Hemodynamics: Physiological Basis, Canine Cardiovascular, pressure measurements.
A Cardiovascular Pressure – Dimension Analysis System: System setup, Data Acquisition and Analysis, Clinical Significance.
Healthcare Information management Systems:
Medical Informatics: Defining medical informatics, Computers in medicine, Electronic Medical record, Computerized physician order entry, Decision support.
Information Retrieval, Medical Imaging, Patient Monitoring, Medical Education, Medical Simulation.
Managing Disparate Information: ActiveX, ActiveX Data Objects (ADO), Dynamic Link Libraries, Database Connectivity, Integrated Dashboards.

Note: Supporting experiments to be carried out wherever necessary

REFERENCE BOOK:

**BIOSENSOR**

Subject Code: 12LBI253  
Hrs/Week: 04  
Total No. of Lecture Hours: 50

**Introduction:** What are Biosensors? Advantages and limitations, various components of biosensors, the growing of biosensor.

**Application and Uses of Biosensors:** Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food. Biosensors for personal diabetes management, application of biosensors to environmental samples, Biochips and their application to genomics.

**Transducers in Biosensors:** Various types of transducers; principles and applications - Calorimetric, optical, potentiometric / amperometric conductometric/resistometric, piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics based transducers. Chemiluminescences - based biosensors.

**Ion-selective Potentiometric Measurement:** Measurement of H+, Ion selective interfaces, Ion selective electrodes

**Semiconductor Electrodes:** MIS structures, semiconductor solution interface, FET, Chemical sensitive FETA (CHEMFETA), Gas-sensitive Metal Gate (IGFET), Suspended gate field effect transistor(SGFET), selectivity via pattern recognition, Ion selective FET (ISFET), reference FET, CHEMFET, assessment of CHEMFETS.

**Amperometric Assay Techniques:** Analysis of charge transfer, volumetric techniques, potential step techniques, non steady state measurement, and applications of charge transfer measurement of the oxygen electrode. Source of error – Depletion of sample, non-Faradic current error, selectivity interference from other electro active species, Amperometric electrodes for estimation of Ion concentration, macromolecules system, Redox enzymes, modified electrodes, microelectrode fabrication and application.

**Photometric Assay Techniques:** Energy transition, ultraviolet and visible absorption spectra, fluorescence and phosphorescence, infra Red transitions, light scattering, Raman scattering, applications of ultraviolet visible spectra, the optical transducer, wave guides in sensors, device construction

**Optical Biosensors & Other Techniques:** Chemiluminescence, bioluminescence, surface plasma resonance, piezoelectric based sensors and surface acoustic waves.

**Reference Books:**
BIOINFORMATICS AND APPLICATIONS

Subject Code: 12LBI254  
IA Marks: 50  
Hrs/Week: 04  
Exam Marks: 100  
Total No. of Lecture Hours: 50  
Exam hours: 03

The Central Dogma: Watson’s definition, information flow, from data to knowledge. Convergence, the organization of DNA, the organization of Proteins.

XML (Bio XML) for Bioinformatics: Introduction, Differences between HTML and XML, fundamentals of XML, fundamentals of XML namespaces. Introduction to DTDs, Document type Declarations, Declaring elements, declaring attributes, working with entities XML Schemas, Essential Concepts, working with simple types, working with complex types, Basic namespaces issues.

Perl (Bioperl) for Bioinformatics: Representing sequence data, program to store a DNA sequence, concatenating DNA fragments, Transcription, Calculating the reverse complement in Perl, Proteins, files, reading proteins in files, Arrays, Flow control, finding motifs, counting Nucleotides, exploding strings into arrays, operating on strings, writing to files, subroutines and bugs.

Databases: Flat file, Relational, object oriented databases, object Relational and Hypertext, Introduction to database design, DBMS Architecture, Schema Architecture, SQL and Introduction to database application development.

Sequence Alignment Algorithms: Biological motivations of sequence analysis, the models for sequence analysis and their biological motivation, global alignment, local alignment, End free-space alignment and gap penalty, Sequence Analysis tools and techniques.

Phylogenetic Analysis: Introduction, methods of Phylogenetic analysis, distance methods, the neighbor- Joining (NJ) method, The Fitch/ Margoliash method, character-based methods, Other methods, Tree evaluation and problems in phylogenetic analysis.

Clustering: Protein structure visualization and Protein structure prediction

REFERENCE BOOKS:
2. “XML for Bioinformatics” CERAMI.
4. “Bioinformatics Computing” Bryan Bergeron, M.D
The medical device as an entity:
What is a medical device?, Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposal, Reliability: Definition, Quality Vs Reliability, Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability’s effects on medical devices.
Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure, Failure due to human errors, Failures from customer’s point of view.
Safety and Risk Management: Medical device safety and risk management,
Effectiveness/performance of medical devices, Phases in the life span of a medical device,
The risk management processes, Tools for risk estimation, Participants in ensuring the safety of medical devices, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance

Standards and Regulations Background
The Medical Devices Directives: Definition of a medical device, The Medical Devices Directives process, Choosing the appropriate directive, Identifying the applicable essential requirements, Identification of corresponding harmonized standards, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, In-vitro Diagnostic Medical Devices Directives.

Basic principles of IPR laws: History of IPR-GATT, WTO, WIPO & TRIPs, Role of IPR in Research & Development & Knowledge era, Concept of property, Marx’s theory of property, Constitutional Aspects of Intellectual property, Different forms of IPR – copyright, trade mark, Industrial Designs, Layout designs of Integrated circuits, Patents, Geographical Indications, Traditional Knowledge, Plant varieties, Trade secrets
Patent application procedure and drafting: Patent Drafting: Format, Provisional & Complete specifications. Scopes of inventions, description of invention, drawings, claims. Filing requirements: Forms to be sent, Comparison of Patentability in different countries, filing mechanism-through individual patent office. PCT route & claiming priority from either route.

Industrial Designs: Introduction, Justification, Subject matter of design law definition, Excluded subject matter Law relating to industrial design and registration in India, Infringement of design rights.

Semiconductor & IC Layout Designs: semiconductor topography design rights. Infringement, Case studies.

Medical Ethics: Theory, principles, rules and moral decisions, Belmont report, the principles of biomedical ethics: respect for autonomy, voluntariness information and informed consent, competency, nonmaleficence, the rule of the double effect, beneficence, paternalism, justice, Examples.

10 Hrs

TEXT BOOKS:

REFERENCE BOOKS:
1. World Intellectual Property Organizations (WIPO) Handbook/ Notes
2. Medical device regulations: global overview and guiding principles Michael Cheng, World Health Organization
4. D.H. Lawerance, Chapter 2, Principles of biomedical ethics Jones & Bartlet publishers
1. To conduct a suitable experiment to determine the Pitch (time domain) and formant frequencies
2. Examine effect of window shape and duration on energy, autocorrelation or speech spectrogram.
3. To conduct a suitable experiment to determine LPC using autocorrelation and covariance method
4. To develop a suitable program for analyzing voiced/unvoiced detector.
5. To determine Spectrogram of speech signals.
6. Determine the minimum prediction error co-efficient of speech signal.
7. Medical Image enhancement – (Histogram based)
8. Medical Image smoothing
9. Medical Image sharpening
10. Algorithm for low pass filter, high pass filter, median filter
11. Point detection, Line detection, Edge detection (Masks operations)
12. Medical Image Segmentation (Water shed segmentation, Fuzzy k means clustering)
14. Applications of Wavelets in Medical Image Processing
Subject Code : 12LBI41  IA Marks : 50
No of Lecture Hrs/Week : 04  Exam hours : 03
Total No. of Lecture Hours : 50  Exam Marks : 100


**Introduction to BioMEMS Microactuators and Drug Delivery**: What are BioMEMS, the Driving force behind Biomedical Applications, Biocompatibility, Reliability Considerations Regulatory Considerations, Activation Methods, Microactuators for Microfluidics, Equivalent Representation, Drug Delivery, Introduction to Clinical Laboratory Medicine, Chemistry, Hematology, Immunology, Microbiology, Urinalysis, Coagulation Assays, Arterial Blood gases. 08 Hrs.

REFERENCE BOOKS:
7. Steven S. Saliterman, “Fundamentals of BioMEMS and Medical Microdevices”, CENGAGE Learning, INDIA EDITION.
BIOSTATISTICS

Subject Code : 12LBI421  IA Marks : 50
No of Lecture Hrs/Week : 04  Exam hours : 03
Total No. of Lecture Hours : 52  Exam Marks : 100


Basic Probability Concepts: Introduction, two views of probability – objective and subjective, elementary properties of probability, calculating the probability of an event.

Probability Distributions: Introduction, probability distribution of discrete variables, binomial distribution, Poisson distribution, continuous probability distributions, normal distribution and applications.

Sampling Distribution: Introduction, sampling distribution, distribution of the sample mean, distribution of the difference between two samples means, distribution of the sample proportion, distribution of the difference between two sample proportions.

Estimation: Introduction, confidence interval for population mean, t-distribution, confidence interval for difference between two population means, population proportion and difference between two population proportions, determination of sample size for estimating means, estimating proportions, confidence interval for the variance of normally distributed population and ratio of the variances of two normally distributed populations.

Hypothesis Testing: Introduction, hypothesis testing – single population mean, difference between two population means, paired comparisons, hypothesis testing-single population proportion, difference between two population proportions, single population variance, ratio of two population variances.

Analysis of Variance (ANOVA): Introduction, completely randomized design, randomized complete block design, repeated measures design, factorial experiment.

Linear Regression and Correlation: Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient.

Multiple Regression and Chi-Square Distribution: Multiple linear regression model, obtaining multiple regression equation, evaluating multiple regression equation, using the multiple regression equation, multiple correlation model, mathematical properties of Chi-square distribution, tests of goodness of fit, tests of independence, tests of homogeneity, nonparametric regression analysis.

REFERENCE BOOKS:
Biomechanics and Rehabilitation Engineering

Subject Code: 12LBI422 IA Marks: 50
No of Lecture Hrs/Week: 04 Exam hours: 03
Total No. of Lecture Hours: 50 Exam Marks: 100

Biomechanics Applications to Joint Structure and Function: Introduction to Kinematics; Displacement in space; Force vectors and gravity; Linear forces and concurrent forces; Kinetics of rotary and translatory forces; Classes of levers; Close chain force analysis.

Constitutive Equations: Equations for Stress and Strain; Non-viscous fluids; Newtonian viscous fluids; Elastic solids; Visco-elasticity and its applications in biology.

Joint Structure and Function: Properties of connective tissues; Human Joint design; Joint Function and changes in disease.

Integrated Functions: Kinetics and Kinematics of Poistures; Static and Dynamic Poistures; Analysis of Standing, Sitting and Lying Poistures.

Gait: Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.


Finite Element Analysis in Biomechanics: Model creation, Solution, Validation of results and applications of FEA.

REFERENCE BOOKS
3. “Biomechanics, Structures and Systems”, A. A. Biewener, Sports Publication
WAVELETS IN BIOMEDICAL ENGINEERING

Subject Code : 12LBI423  IA Marks : 50
No of Lecture Hrs/Week : 04  Exam hours : 03
Total No .of Lecture Hours : 50  Exam Marks : 100

Wavelet Transforms: Overview of WT, fundamentals-FT, STFT, resolution, Multi resolution analysis-CWT,
DWT
WAVELETS IN MEDICAL IMAGING AND TOMOGRAPHY
  Applications of wavelet shrinkage to tomography
  Wavelet denoising of functional MRI data
  Statistical analysis of image differences by wavelet decomposition
  Feature extraction in digital mammography
  Adapted wavelet techniques for encoding MRI diagnosis of coronary artery disease using wavelet based neural networks.

REFERENCE BOOKS:
1. “Tutorial on Wavelets”, part I-IV, RobiPolikar (WWW.Rohen University.edu)
Chapter- I Modeling continuous – time signals as sums of sine waves
Introduction, analysis of circadian rhythm, orthogonal functions, sinusoidal basis functions, the Fourier series, the frequency response and non-sinusoidal periodic inputs, Parseval’s relation for periodic signals, CTFT, relationship of Fourier transform to frequency response, properties of the Fourier transform, the generalized Fourier transform, examples Fourier transform calculations, Parseval’s relation for nonperiodic signals, filtering, output response via the Fourier transform.

Chapter-II Modeling signals as sums of discrete-time sine waves
Introduction, introductory example, the discrete-time Fourier series, Fourier transform of discrete-time signals, Parseval’s relation for DT nonperiodic signals, output of an LSI system, relation of DFS and DTFT, windowing, sampling, DFT, biomedical applications.

Chapter-III Modeling stochastic signals as filtered white noise
Introduction, EEG analysis, random processes, mean and auto correlation function of random process, stationarity and ergodicity, general linear processes, Yule-Walker equations, Autoregressive(AR) processes, Moving Average (MA) processes, Autoregressive - Moving Average (ARMA) processes, harmonic processes, biomedical examples.

Chapter-IV Non linear models of signals
Introduction, non linear signals and systems, Poincare sections and return maps, chaos, measures of non linear signals and systems, characteristic multipliers and Lyapunov exponents, estimating the dimension of real data, tests of null hypotheses based on surrogate data, biomedical applications.

Chapter-V Modeling biomedical systems
Problem statement, illustration of the problem, point processes, parametric system modeling, autoregressive or all-pole modeling, pole-zero modeling, electromechanical models of signal generation, applications.

REFERENCE BOOKS:
ARTIFICIAL INTELLIGENCE AND PATTERN RECOGNITION

Subject Code : 14LBI425 IA Marks : 50
No of Lecture Hrs/Week : 04 Exam hours : 03
Total No.of Lecture Hours : 50 Exam Marks : 100

1 .Introduction: Machine perception, an example; Pattern Recognition System; The Design Cycle, Learning and Adaptation.


3. Bayesian Decision Theory: Minimum Error Rate Classification, Classifiers, Discriminant functions, and decision surfaces; the normal density; Discriminant functions for the normal density.


6 Clustering: Introduction, Hierarchical clustering, Partitional clustering.

7. Introduction to Biometric Recognition: Biometric Methodologies: Finger Prints; Hand Geometry; Facial Recognition; Iris Scanning; Retina Scanning;

REFERENCE BOOKS: