M.Tech.: BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

Outcome Based Education (OBE) and Choice Based Credit System (CBCS): 2018-19

SYLLABUS – I SEMESTER

REAL TIME SIGNAL PROCESSING				
Subject Code	**: 18LBI11**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. Understand and Master over the basics of digital signal processing.
2. Apply and implement various transforms in real time applications.
3. Analyze programmable system on chip architecture and its importance.
4. Appreciate adaptive filtering algorithms and multi rate signal processing algorithm applications.

Module-1:

Introduction to Discrete Fourier Transform (DFT) and its relationship with other transforms. DFT properties.

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.

Module-2:

Direct computation of DFT, Need for efficient computation of DFT (FFT Algorithms). 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.

Module-3:

IIR Filter Design: Design of IIR filters from analog filters (Butterworth and Chebyshev). Impulse invariance method and bilinear transformation methods. Verification for stability and linearity during mapping.

Module-4:

Implementation of discrete time systems: Structures for IIR and FIR systems -Direct form I, Form-II, Cascade and parallel realizations.

Multirate Signal Processing: Concepts of multirate signal processing, Sampling rate converter, decimators and interpolators.

Module-5:

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

Adaptive Digital Filters: Concepts of Adaptive filtering, LMS adaptive algorithm, Recursive least square algorithm.

Course Outcomes: At the completion of this course, students will be able to:

1. Explain and comprehend various transforms in real time applications.
2. Apply transforms in implementing various biomedical signal processing applications.
3. Analyze and modify the adaptive filtering algorithms for improved performance.

4. Develop an interest to study about Biosignals and designing projects for processing the biosignals for practical applications.

Reference Books:

1. Digital Signal Processing - John G Proakis and Dimitrius G Manolakis, 3rd Edn, PHI, ISBN: 81-203-1129-9
2. Digital Signal Processing - Emmanuel C Ifeachor and Barrie W Jervis, 2nd Edition, Pearson Education 2004.ISBN:81-7808-609-3
3. Real Time Digital Signal Processing, Fundamentals, Algorithms and implementation using TMS processors - V.Udhayashankara, PHI Publishing, 2010, ISBN: 978-81-203-4049-7
4. ARM System On Chip Architecture – Steve Furber, 2nd edition, Pearson Publication, ISBN: 978-81-317-0840-8
5. Digital Signal Processors - B Venkataramani and M Bhaskar, TMH, New Delhi 2002

PHYSIOLOGY FOR BIOMEDICAL ENGINEERING				
Subject Code	**: 18LBI12**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives:

1. To learn basic aspects of human physiology.
2. To develop an understanding of the engineering approach toward understanding biological functions of various body systems.

Module-1:

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.

Module-2:

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.

Module-3:

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.

Module-4:

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.

Module-5:

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.

Physiology of Eye and Ear: Structure of the Eye, Visual process, Field of vision, Visual pathway, Pupillary reflexes, Colour vision, Errors of refraction. ERG and EOG. Structure of ear, Auditory defects.

Course Outcomes: At the completion of this course, students will be able to:

1. Describe human physiology at a cellular, tissue, and organ systems level.

2. Discuss the integration and control of the different physiological systems and their roles in maintaining homeostasis.
3. Develop basic knowledge in working of major body systems and the physiological parameters associated with them.

Reference Books:

1. Essentials of Medical Physiology - K Sembulingam & Prema Sembulingam (Jaypee Publications, 2004).
2. Concise Medical Physiology - Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.

MEDICAL INSTRUMENTATION				
Subject Code	**: 18LBI13**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To create awareness about the different signals arising from the human body and the equipments used to measure these signals.
2. To study the principles of various diagnostic and therapeutic equipments.
3. To give an overview of the components contained in a typical man-machine system.
4. To give the students a taste of the applications of the theories taught in the subject.
5. To give the students a useful skill base that would allow them to carry out further study should they be interested to work in the field.

Module-1:

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), Electroretinogram (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.

Module-2:

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.

Module-3

Patient Monitoring Systems & Oximeters: Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement ,Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method. Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter.

Module-4:

Blood Flow Meters, Cardiac Pacemakers and Defibrillators:

Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters. Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator. Defibrillator electrodes, DC defibrillator with synchronizer.

Module-5:

Respiratory & Advanced Diagnostic & Therapeutic Instruments: Pulmonary function measurement, basic spirometer, ultrasonic spirometer, Pneumotachometer, Measurement of

volume by Nitrogen washout technique. Artificial kidney-Principle and haemodialysis machine. Lithotriptors- principle, modern lithotriptor-block diagram and working. Anesthesia-Need for anesthesia, delivery of anesthesia, anesthesia machine. Infusion pumps-principle and programmable volumetric infusion pump.

Course Outcomes: After going through this course the student will be able to;

1. Discuss the sources of biomedical signals, design a medical instrumentation system taking into account the general constraints.
2. Describe the different types of electrodes used for picking the bioelectric signals.
3. Design suitable recording systems considering the characteristics of bioelectric potentials.
4. Discuss the instrumentation used for measuring the nonelectrical parameters.

Reference Books:

1. R. S. Khandpur , Handbook of Biomedical Instrumentation, Tata McGraw-Hill ,2nd Edition, 2008, ISBN: 9780070473553.
2. Leslie Cromwell & others, Biomedical Instrumentation and Measurements, Wiley Publications, 2nd Edition, 2010, ISBN: 9780130771315.
3. J. G. Webster, Medical instrumentation: Application and Design, Wiley Publications, 3rd Edition, 2008,ISBN: 9788126511068.
4. Richard Aston, Principles of Biomedical Instrumentation and Measurement, Prentice Hall of India, 4th Edition, 2005,ISBN: 9780675209434.

ADVANCED BIOMEDICAL SIGNAL PROCESSING

Subject Code	**: 18LBI14**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To study the fundamental theory of Biomedical signal processing.
2. To learn the different types of processing techniques carried out for enhancing the relevant information.
3. To implement biomedical signal processing protocol to solve practical problems.

Module-1:

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.

Module-2:

ECG Data Reduction: Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loeve 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.

Module-3:

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,

Time Series Analysis: Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models. Spectral modeling and analysis of PCG signals.

Module-4:

Spectral Estimation: Introduction, Blackman- tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD techniques. Comparison of the PSD estimation methods.

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.

Module-5:

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.

Course Outcomes: Upon completion of this course, the student should be able to:

1. Implement the various types of processing techniques carried out on biomedical signals which meet the current Industry needs.

2. Develop an interest to design new modeled algorithm more and more continually.
3. Develop an interest to simulate the models and validate its functionality in real time systems.
4. Demonstrate an ability to integrate different concepts to develop new models that suits current trends of Industries and analyze its performance.

Reference Books:

1. Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I)- Arnon Cohen, CRC press, 1986.
2. Biomedical Signal Analysis-A case study approach - Rangaraj M. Rangayyan, Wiley-IEEE Press, 2002.
3. Biomedical Signal Processing Principles and Techniques - D.C.Reddy, Tata McGraw-Hill, 2012.
4. Biomedical Digital Signal Processing - Willis J. Tompkins, PHI, 2000.

MEDICAL IMAGING TECHNIQUES AND SYSTEMS

Subject Code	**: 18LBI15**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives:

1. To give an idea about generation and to impart knowledge about various X-Ray diagnostic methods.
2. To study the principles of ultra sound imaging.
3. To create awareness about medical imaging using radio nucleides.
4. To give the concept and application of MRI.

Module-1:

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

X-Ray : Interaction between X-Rays and matter, Intensity of an X-Ray, Attenuation, X-Ray Generation and Generators, Beam Restrictors and Grids, Intensifying screens, fluorescent screens and Image intensifiers, X-Raydetectors, Conventional X-Ray radiography, Fluoroscopy, Angiography, Digital radiography, X-Ray image characteristics, Biological effects of ionizing radiation.

Module-2:

Computed Tomography : Conventional tomography, Computed tomography principle, Generations of CT machines – First, Second, Third, Fourth, Fifth, Sixth & Seventh, Projection function,

Reconstruction algorithms – Back Projection Method, 2D Fourier Transform Method, Filtered Back Projection Method, Iteration Method, Parallel Beam Reconstruction, Fan Beam Reconstruction, Helical CT Reconstruction.

Module-3:

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.

Module-4:

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

Infrared Imaging

Physics of thermography – imaging systems – pyroelectricvidicon camera clinical thermography – liquid crystal thermography.

Module-5:

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.

Course Outcomes: After going through this course the student will be able to;

1. Explain the principle, components and procedure of different imaging modalities.
2. Select suitable imaging technique for particular application.
3. Analyze the images obtained from different imaging techniques for diagnosis and treatment.

Reference Books:

1. "Principles of Medical Imaging", K Kirk Shung, Michael B Smith & Benjamim M W Tsui, Academic Press Inc.
2. "Hand Book of Biomedical Instrumentation", R S Khandpur, Tata McGraw Hill Publication, Second Edition.
3. "Medical Imaging Signals and Systems", Jerry L Prince & Jonathan M Links, Pearson Prentice Hall.
4. Steve Webb, "The physics of medical imaging", Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
5. "Basics of MRI", Ray H Hashemi & William G Bradley Jr, Lippincott Williams & Wilkins.
6. "Diagnostic Ultrasound Principles & Instruments", 5th Edition, Frederick W Kremkau.
7. "2D Echocardiography", Jay N Schapira, Williams & Wilkins

BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION LAB

Subject Code	**: 18LBIL16**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 02**		**SEE Marks**	**: 60**
Total Lab Hours	**: 56**		**Exam Hours**	**: 03**

Course Objectives:

1. To make the students to become familiar with biomedical data acquisition systems
2. To inculcate the fundamental techniques of biomedical signal analysis
3. To make the students to become familiar with biomedical signal processing algorithms and their implementation.

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)
6. Study and acquisition of PPG and Realization of a Pacemaker circuit.
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.
12. Data Compression Techniques: AZTEC, TP, FAN algorithms.
13. Design of Wiener Filter to remove Artifacts in ECG Signal.
14. Design of Adaptive Noise Canceller for the removal of Interference and Noise in Bio signals.

Course Outcomes: After going through this course the student will be able to

1. Develop / Use data acquisition systems for biomedical signal analysis
2. Apply suitable signal processing algorithms for biomedical signal analysis and feature extraction.
3. Design and implement digital filtering and data compression techniques on biomedical signals.

RESEARCH METHODOLOGY AND IPR				
Subject Code	**: 18RMI17**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 02 & 02**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 25**		**Exam Hours**	**: 03**
Each Module 5 Hrs.				
Course Objectives:				
Module-1:				
Module-2:				
Module-3:				
Module-4:				
Module-5:				
Course Outcomes:				
Reference Books:				

M.Tech. : BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

Outcome Based Education (OBE) and Choice Based Credit System (CBCS): 2018-19

SYLLABUS – II SEMESTER

ADVANCED MEDICAL IMAGE PROCESSING				
Subject Code	**: 18LBI21**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**
Each Module 10 Hrs				

Course Objectives:

1. To give an idea of the state of the art in image processing by examining some of the principal areas in which it is applied.
2. To discuss briefly the principal approaches used in digital image processing.
3. To give an overview of the components contained in a typical general purpose image processing system.
4. To understand the state of the art in enhancement techniques and how they operate on digital images.
5. Give the students a taste of the applications of the theories taught in the subject. This will be achieved through the project and some selected lab sessions.
6. Give the students a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

Module-1:

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.

Module-2:

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

Module-3:

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

Module-4:

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.

Module-5:

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.

Course Outcomes: After the completion of this course the student will be able to;

1. Explain the fundamentals of digital image processing including the topics of filtering,

transforms, and morphology, and image analysis and compression.
2. Implement basic image processing algorithms in MATLAB.
3. Evaluate and synthesize the data coding and compression techniques on images.
4. Implement and evaluate algorithms for image analysis based on segmentation, shape & texture, registration, recognition and classification.
5. Use MATLAB for implementing image processing algorithms of segmentation, registration, object recognition and classification.
6. Develop skills necessary to further explore advanced topics of Digital Image Processing.

Reference Books:

1. "Digital Image Processing" Rafael C. Gonzalez & Richard E. Woods, Second Edition. Pearson Education Inc.
2. "Fundamentals of Digital Image Processing" Anil K. Jain. Prentice Hall of India.
3. "Image Processing, Analysis and Machine Vision" Milan Sonka, Vaclav Hlavac & Roger Boyle, 2nd Edition.
4. "Digital Image Processing" Rafael C. Gonzalez & Richard E. Woods, First Edition. Pearson Education Inc.
5. "Practical Algorithms for Image Analysis" Description, Examples & Codes by Michael Seul, Lawrence O'Gorman, Michel J.Sammon, Cambridge University Press.
6. "Biomedical Imaging visualization and analysis" Richard A Robb, John Wiley& sons, Inc. publication.

SPEECH SIGNAL PROCESSING				
Subject Code	**: 18LBI22**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. Introducing the fundamental concepts of sound production in the vocal tract and various types of digital modules in approximating this process.
2. To develop time and frequency representations methods of speech signals.
3. To analyze linear predictive coding of speech.
4. To apply speech recognition and speech synthesis principles for various applications.

Module-1:

Digital Models for Speech Signals: Process of Speech Production, The Acoustic Theory of speech production, Digital models for Speech signals.

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

Module-2:

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

Module-3:

Digital Representations of the Speech Waveform: Sampling speech signals, Review of the statistical model for speech, Instantaneous quantization, Adaptive quantization, General theory of differential quantization, Delta modulation, Differential PCM, Comparison of systems.

Module-4:

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.

Module-5:

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.

Speech Recognition: Principles of Speech recognition, Speech period detection, Spectral distance measures, Structure of word recognition systems, Dynamic time warping (DTW), Word recognition using phoneme units.

Course Outcomes: After the completion of this course the student will be able to:

1. Explain the various digital models for speech production
2. Apply short time principles in digital speech processing to estimate various parameters of speech.
3. Analyze different forms of Digital representation of speech.
4. Synthesize the concepts of speech synthesis and speech recognition to different

applications.
Reference Books:
1. Digital Processing of Speech Signals", L R Rabiner and R W Schafer, Pearson Education 2004. 2. "Digital Speech Processing, Synthesis and Recognition", Sadoaki Furui, Second Edition, Mercel Dekker 2002. 3. "Designing with speech processing chips", Ricardo Jimenez, Academic press, INC 1991. 4. "Introduction to Data Compression", Khalid Sayood, Third Edition, Elsevier Publications. 5. "Digital Speech", A M Kondoz, Second Edition, Wiley Publications

NEURAL NETWORK AND FUZZY LOGIC IN MEDICINE				
Subject Code	**: 18LBI23**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. This course aims at introducing the fundamental theory of neural networks and fuzzy systems.
2. The objective is intended for students to understand the principle of neural or fuzzy control and then apply neural networks and fuzzy systems to model and solve complicated practical problems such as recognition.
3. Describe the learning and retrieval procedures of various neural networks model.
4. Analyze and apply neural networks and fuzzy systems to solve practical problem.

Module-1:

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

Module-2:

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

Module-3:

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.

Module-4:

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

Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Operations on Fuzzy Sets, Fuzzy Arithmetic, Compliment, Intersections, Unions, Fuzzy Relation.

Module-5:

Fuzzy Rule based system Linguistic Hedges. Rule based system, Graphical techniques for Inference, Fuzzification and Defuzifications, fuzzy additive models Applications.

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 LabView

Course Outcomes: After completion of this course the student will be able to:

1. Compare the difference between biological and artificial neural network.
2. Describe regression and classification method
3. Describe Single layer initialize theorem
4. Analyze the generalized radial basis function networks.

Reference Books:

1. S. Haykin, “Neural networks: A Comprehensive Foundation”’ Pearson Education (Asia) Pvt. Ltd/Prentice Hall of India, 2003.
2. Vojislav Kecman, “Learning and soft computing”, Pearson Education (Asia) Pvt. Ltd.2004.
3. Timothy J Ross ,Fuzzy logic with Engineering Applications, McGraw Hill Publication, 2000.
4. M.T.Hagan, H.B.Demuth and M. Beale, “Neural Network Design”, Thomson Learning, 2002.
5. Bart Kosko, “Neural Networks and Fuzzy Systems” Prentice Hall of India, 2005
6. George J. Klir and Bo Yaun, “Fuzzy sets and Fuzzy Logic: Theory and Application”, Prentice Hall of India, 2001.

LASERS IN MEDICINE				
Subject Code	**: 18LBI241**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives:

1. Understanding the basics of lasers and fiber optic system
2. Comprehend basic physical principles for use of laser in diagnostic and therapeutic medicine.
3. Apply the optical properties of tissues, the effects of multiple scattering on light mathematical methods.
4. Analyze applications of absorption spectroscopy and factors that limit its accuracy in medicine.

Module-1:

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.

Module-2:

Optical and Thermal Response of Tissue to Laser Radiation: Introduction, The optical response of tissue, thermal response.

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

Module-3:

Tissue Diagnostics using Laser: Introduction, light interaction with tissue, spectroscopic diagnostics of malignant tumor, spectroscopic diagnostics of atherosclerotic plaque, light scattering and tissue Transillumination.

Module-4:

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.

Module-5:

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

Course Outcomes: After the completion of this course the student will be able to;

1. Explain the principle and working of different types of laser sources.
2. Select laser for the application intended.
3. Comprehend the tissue reactions to various Laser types
4. Analyze the effect of using Lasers for diagnosis, therapeutic and treatment of various health issues.
5. Apply the knowledge to various healthcare applications.

Reference Books:

1. Wilson and Hawkes, 'Laser principles and applications', Prentice Hall of India, 7th Edition, 1987, ISBN: 978-0135237052.
2. Raymond W. Waynant (Editor), "Lasers in Medicine", CRC press, Jan 2002.
3. Julian D.C. Jones Collin E. Webb (Editor), "Handbook of Laser Technology and Application".
4. Kapur, Raman, 'Soft Lasers in Medical Practice', Jaypee Bros, Medical Publishers.

BIOINFORMATICS AND APPLICATIONS

Subject Code	**: 18LBI242**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. This course aims at introducing the fundamental concepts of organization of DNA and Protein sequences.
2. The objective is intended for students to understand the concepts of statistical tools and algorithms to analyze and determine relationships between biological data sets, such as macromolecular sequences, structures, expression profiles and biochemical pathways.
3. This course gives the knowledge of programming in different languages such as HTML, XML and Perl.
4. This course imparts the basic concepts and ideas of methods of Phylogenetic Analysis.

Module-1:

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.

Module-2:

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.

Module-3:

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.

Module-4:

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.

Module-5:

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.

Course Outcomes: After completion of this course the student will be able to;

1. Explain the relationship of molecular biology and bioinformatics to computer science.
2. Discuss the basics of XML programming briefs about the DTDs and the XML Schemas.
3. Develop technique to concatenate two DNA fragments

4. Apply the knowledge in creation of the database. 5. Discuss about the biological motivation of sequence analysis.
Reference Books:
1. Bioinformatics Methods and Applications", S.C.Rastogi, N. Mendiratta. 2. "XML for Bioinformatics" CERAMI. 3. "Beginning Perl for Bioinformatics" James D. Tisdall. 4. "Bioinformatics Computing" Bryan Bergeron, M.D

BIOSENSORS				
Subject Code	**: 18LBI243**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives:

1. Comprehend the fundamental theory of biosensors.
2. Analyze the working mechanisms of the most common types of biosensors.
3. Apply knowledge to design a specific transduction mechanism.
4. Evaluate the transducer selection for application.

Module-1:

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 personal diabetes management. Biochips and their application to genomics.

Module-2:

Transducers in Biosensors: Various types of transducers; Principles and applications - optical, potentiometric, amperometric, conductrometric/resistormetric, piezoelectric, semiconductor, impedimetric.

Module-3:

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.

Module-4:

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.

Module-5:

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.

Course Outcomes: After successfully completing this course students are able to;

1. Explain the various sensors and transducers available for physiological and cellular measurements and their applications.
2. Apply the operations of various sensors in a biosensing system.

3. Analyze electrical/mechanical engineering concepts for a range of problems and medical applications.
4. Design and synthesize the transducer usage for various biosensor applications.

Reference Books:

1. "Biosensors" Elizabeth A. H Hall - Open University press, Milton Keynes.*ISBN*-10: 0471932264.cf
2. "Commercial Biosensors" Graham Ramsay, John Wiley and son, INC. 1998.*ISBN* 978-0-471-58505-3.
3. "Enzyme Technology" Dr.S.Shanmugam, I. K. International Pvt Ltd,2009. ISBN9380026056, 9789380026053
4. "Biosensors edited by AEG CASS" – OIRL press, Oxford University.
5. "Transducers and Instrumentation", Murthy D V S. Prentice Hall, 1995.

VIRTUAL BIO-INSTRUMENTATION				
Subject Code	**: 18LBI244**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives:

1. It provides new concepts towards biomedical measurement and instrumentation.
2. It imbibes knowledge of data acquisition and analysis of biomedical signals using LabView virtual instrumentation tools.

Module-1:

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 setup, Di section, Nerve chamber preparation, generic VI Development, Experiment descriptions, Troubleshooting the nerve recording.

Module-2:

Neuromuscular Electrophysiology (Electromyography): Physiological basis, Experiment set up, Experiment descriptions, Troubleshooting the nerve –Muscle Preparation.

Cardiac Electrophysiology (Electrocardiology): Physiological basis, Experiment descriptions.

Cardiopulmonary Dynamics : Typical Laboratory Workstation, Generic Instrumentation/Data Acquisition Issues.

Module-3:

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.

Module-4:

Medical Device Development Applications: The Endotester – A Virtual Instrument –Based Quality control and Technology, Assessment System for surgical video Systems: Introduction, Materials and Methods, Endoscope Tests, Results, Discussion.

Fluid Sense Innovative IV Pump Testing : Introduction, The test System, Training Emulator.

Module-5:

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.

Course Outcomes: At the end of the course, the student will be able to;

1. Apply virtual instrumentation concept for data acquisition of biomedical signals.
2. Identify salient features of virtual bio-instrumentation tool to conduct lab experiments and possible incorporation of these traits in the projects.
3. Develop LabView based simple programs to build virtual bio-instrumentation tools for biomedical signal analysis.

Note: Supporting experiments to be carried out whereever necessary.

Reference Book:

"Virtual Bio-Instrumentation" Biomedical, Clinical, and Healthcare Applications in Lab VIEW by JON B. OLANSEN and ERIC ROSOW, Prentice Hall Publication, 2002.

BIOMATERIALS AND ARTIFICIAL ORGANS

Subject Code	**: 18LBI251**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Learning Objectives

1. To provide a general understanding of the multidisciplinary field of biomaterials
2. To understand the interactions at the interface of material and biological systems
3. To study the physical, mechanical and biological properties of materials which can be implanted in the human body and their bio-compatibility
4. To acquaint the student with modern artificial organs devices and methods used to partially support or completely replace pathological organ.

Module-1:

Structure of Bio-Materials and Bio-Compatibility

Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound-healing process, body response to implants, blood compatibility.

Module-2:

Implant Materials

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

Module-3:

Polymeric Implant Materials

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

Module-4:

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.

Module-5:

Artificial Organs

Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane) , Dental Implants – Artificial limb & hand.

Course Outcomes: At the end of the course, the student will be able to;

1. Explain the features of biomaterials and the biocompatibility phenomena.
2. Describe principles, construction and working of artificial organs.
3. Discuss the function and relationship between the structure and functionality of chosen artificial organ.

Reference 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
3. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill,

2003.
5. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005.

CLINICAL MEDICINE FOR BIOMEDICAL ENGINEERS				
Subject Code	**: 18LBI252**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To learn basic aspects of clinical Medicine, investigation and treatment of diseases.
2. To develop an understanding of the exact requirements for diagnosis of diseases and development of Instruments.

Module-1:

Introduction to Medicine: History taking, palpation, Percussion, Auscultation, General Physical Examination of the patient.

Respiratory System: Basic investigations in Respiratory diseases which includes x-ray, CT-Scan Pulmonary function tests, Nuclear Medicine imaging, Ultrasound, Serological tests, bronchoscopy, Cough and Sputum, Inflammation of Bronchus, Bronchial-Asthma, COPD, Pulmonary Tuberculosis**.**

Module-2:

Renal and urological Disorders; Investigations in Renal and urology Disease such as renal imaging techniques, uroflowmetry, Haematuria, Acute and chronic Renal failure, Glomerular Diseases, UTI, Renal Calculi.

Cardiovascular System : Investigation in Cardiovascular Disease which includes ECG, Non-invasive methods of cardiac examination ECHO, X-ray, Radionuclide imaging of the heart, New cardiac imaging techniques CT-Angiogram, MRI, PET Scans, Diagnostic cardiac catheterization and Angiography, cardiac arrhythmias and Murmurs, IHD, Hypertension, Cardiac arrest Myocardial infarction**.**

Module-3:

GIS: Basic investigation in GIS such as endoscopy, Blood tests, colonoscopy, Laproscopy, Imaging techniques, Ulcers in Stomach, Liver function test, Hepatitis Cirrhosis of Liver, Gall stones, Chronic Diahorrhea.

Nervous System; Investigation in Neurology CT scan, MRI, EEG , Disorders of Speech, Cranial Nerves, Headaches, Epilepsy, Cerebrovascular Diseases, Myasthenia gravis.

Module-4:

Hematological Disorders; Lab Diagnosis in Haematology, Anaemia, Leukaemia, Lymphoma, blood Transfusion, The spleen.

Endocrine glands; Pituatary gland, Thyroid gland, Adrenals, Pancreas this includes types of Diabetes, management of Diabetes.

Sense organs; **Eye**; Investigations in Diagnosis of blindness, causes of blindness cataract, glaucoma. **E.N.T**; Causes of Deafness, Tests for diagnosis of Deafness.

Module-5:

Infectious Diseases; Diphtheria, Meningitis and analysis of CSF influenza, Chickenpox, Mumps, PUO.

Communicable Diseases; Malaria, Typhoid fever, Leprosy, Dengue, Rabies, worm-Infestations, HIV.

Course Outcomes: At the completion of this course, students will be able to;

1. Explain the common diseases and their treatment procedures.
2. Describe the investigations performed for diagnosing the diseases of individual systems and the equipments used for it and the reasons for using such investigations.
3. Develop basic knowledge about the role of biomedical equipments in diagnosis and treatment of diseases.

Reference Books:

1. Medicine for students A handbook of Medicine by Golwalla 24th Edition.
2. Davidson's Principles and Practice of Medicine, 22nd Edition.
3. Harrisons Principles of internal Medicine, 19th edition.

ARM EMBEDDED SYSTEM DESIGN				
Subject Code	**: 18LBI253**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To define ARM based embedded system and requirements of embedded system.
2. Interpret ARM instructions based on CPU architecture.
3. To analyze ARM CPU performance for high end mobile embedded applications like cell phones.
4. To write assembly and embedded C language to program the ARM processor to perform a defined task.
5. To demonstrate the capability to program the ARM controller to communicate with external circuits.

Module-1:

Introduction To Embedded systems

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.

Module-2:

ARM Embedded Systems and ARM processor fundamentals

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.

Module-3:

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.

Module-4:

Introduction to the thumb instruction set and Exception and interrupt handling

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.

Module-5:

Embedded operating systems and Future of the Architecture

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.

Course outcomes: At the end of the course, the student will be able to;

1. Analyze any ARM version processor with different modes.
2. Write a program using ARM 32bit instruction sets.
3. Write a program using Thumb instruction sets.
4. Write Exception and interrupt handling programs.
5. Develop hardware and software for embedded systems for specific application.

Reference Books:

1. "ARM system developers guide", Andrew N Sloss, Dominic Symes and Chris wright, Elsevier, Morgan Kaufman publishers, 2008,ISBN:1558608745
2. "ARM Architecture reference manual", David seal: Addison-Wesley second edition, 2009, ISBN:978- 0201737196.
3. "ARM System on chip Architecture" Addison Wesley, Formatted: paperback, 2008, ISBN:978- 0201675191.
4. "Embedded Systems", Rajkamal, Tata McGraw-Hill publishers, 2008,ISBN:0070494703.

DATA WAREHOUSINGAND DATA MINING				
Subject Code	**: 18LBI254**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To introduce the basic concepts of Data Warehouse and Data Mining techniques.
2. Examine the types of the data to be mined and apply preprocessing methods on raw data.
3. Discover interesting patterns, analyze supervised and unsupervised models and estimate the accuracy of the algorithms.

Module-1:

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse – Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Module-2:

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation. Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Module-3:

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Module-4:

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Module-5:

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Course Outcomes: Students who complete this course should be able to;

1. Process raw data to make it suitable for various data mining algorithms.
2. Discover and measure interesting patterns from different kinds of databases.
3. Apply the techniques of clustering, classification, association finding, feature selection and visualization to real world data.

Reference Books:

1. Jiawei Han and Micheline Kamber "Data Mining Concepts and Techniques" Second Edition, Elsevier, Reprinted 2008.
2. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining &OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
3. K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
4. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
5. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

SPEECH AND IMAGE PROCESSING LAB

Subject Code	**: 18LBIL26**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 02**		**SEE Marks**	**: 60**
Total Lab Hours	**: 56**		**Exam Hours**	**: 03**

Course Objectives:

1. To understand the basic features of the speech signal and image
2. To develop techniques to analyze the speech signal and image.

Laboratory Experiments: To be conducted by Matlab / LabView / C Programming / DSP Processor kits.

Speech

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.

Image

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)
13. Medical Image Restoration.
14. Applications of Wavelets in Medical Image Processing

Course Outcomes: Students who complete this course should be able to;

1. Implement basic speech processing algorithms in Matlab / LabView / C Programming
2. Implement speech feature extraction algorithms in Matlab / LabView / C Programming
3. Implement basic image processing algorithms in Matlab / LabView / C Programming
4. Implement basic image processing algorithms in Matlab/ LabView / C Programming
5. Implement and evaluate algorithms for image analysis based on segmentation, shape & texture, registration, recognition and classification.
6. Develop skills necessary to implement applications based on speech signal or digital image processing.

M.Tech. : BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

Outcome Based Education (OBE) and Choice Based Credit System (CBCS): 2018-19

SYLLABUS – III SEMESTER

BIO-MEMS AND NANOTECHNOLOGY				
Subject Code	**: 18LBI31**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**
Each Module 10 Hrs				

Course Objectives:

1. To know the fundamentals of MEMS and applications
2. Understand the principles of microsystem design and miniaturization
3. To study the applications of MEMS in the field of biomedical engineering and drug delivery
4. To impart the knowledge about nanotechnology and development of Lab-on-chip

Module-1:

Over view of MEMS& Microsystems and Working Principles of Microsystems: MEMS and Microsystems, Typical MEMS and Microsystem Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystem Design and Manufacture, Applications of Microsystems in Automotive, Health Care, Aerospace and other Industries. **Working Principle of Microsystems: Microsensors:** Acoustic, Chemical, Optical, Pressure, Thermal and Biomedical& Biosensors. **Microactuation:** Using Thermal forces, Shape Memory alloys, Piezoelectric Crystals and Electrostatic forces. **MEMS with Microactuators:** Microgrippers, Micromotors, Microvalves and Micropumps.

Module-2:

Thermo-fluid Engineering and Microsystem Design, Scaling Laws in Miniaturization: Introduction to Thermofluid Engineering, Overview of the Basics of Fluid Mechanics in Macro and Mesoscales: Viscosity of fluids, Streamlines and Stream Tubes, Control Volumes and Control Surfaces, Flow Patterns and Reynolds Number. Basic Equations in Continum Fluid Dynamics: The Continuity Equation, The Momentum Equation and the Equation of motion. Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Microconduits, Fluid Flow in Submicrometer and Nanoscale, Heatconduction in Multilayered Thin Films. Introduction to Scaling, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces and Scaling in Fluid Mechanics.

Module-3:

Materials for MEMS and Microsystems, Microsystems Fabrication Processes: Substrates and Wafers, Active Substrate Materials, Silicon as a Substrate Material, Silicon Compounds, Silicon Piezoresistors, Galium Arsenide, Quartz, Piezoelectric Crystals, Polymers and Packaging Materials. Introduction to Microsystem Fabrication Process, Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapor Deposition (CVD), Physical Vapor Deposition-Sputtering, Deposition by Epitaxy, Etching, The LIGA Process: General

Description of LIGA Process, Materials for Substrates and Photoresists, Electroplating and SLIGA Process.

Module-4:

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.

Module-5:

Micro-Total-Analysis Systems (μTAS): Lab-on-Chip, Capillary Electrophoresis Arrays (CEA), Cell, Molecule and Particle Handling, Surface Modification Microspheres, Cell Based Bioassay Systems. Introduction to Emerging Bio-MEMs Technology, Minimally Invasive Surgery, Point-of-care Clinical Diagnosis, Cardiovascular, Diabetes, Endoscopy, Neurosciences, Oncology Ophthalmology, Dermabrasion, Tissue Engineering, Cell based Biosensors.

Course Outcomes:

1. Describe the fundamentals of microtechnology and nanotechnology, especially those related to bioengineering
2. Explain the main bioengineering-related techniques and processes of micro and nanotechnology
3. Apply micro and nanotechnology to fabricate PDMS-based micro-bio-devices and nanowires/rods for biomedical applications
4. Apply techniques for the characterizations of micro-bio-devices and nanowires/rods used for biomedical applications.

Reference Books:

1. Tai Ran Hsu, "MEMS and Microsystems, Design & Manufacture" , TMH2002.
2. Mohammed had-el-hak, "MEMS Introduction & Fundamentals" ,CRC Press.
3. Harisingh Nalwa, "Nanoscience and Nanotechnology", American Scientific Publishers.
4. Sergey Edward Lyshevski, "Nano &MEMS", CRC press
5. Nadim Maluf, "An Introduction to MEMS Engineering" , Artech House Publishing.
6. Taun-Vo-Dish, "Nanotechnology in Biology & Medicine methods" , devices & Applications, CRC
7. Steven S. Saliterman, "Fundamentals of BioMEMS and Medical Microdevices", Cengage Learning, India Edition.

BIOMETRICS AND APPLICATIONS				
Subject Code	**: 18LBI321**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives: This course concentrates on the unique advantages that biometrics brings to computer security, but also addresses challenging issues such as algorithms, recognition, and performance, as well as alternatives of passwords and smart cards. Students will gain knowledge in the building blocks of this field: security and privacy, and secure systems design. By the end of the course students will be able to evaluate and design security systems that include biometrics

Module-1:

Introduction to Biometrics : Biometrics as authentication scheme, operation of a biometric system, verification versus identification, performance of a biometric system, error and accuracy in biometric systems, applications of biometrics, biometric characteristics and types, forensic biometric traits, dental, voice, signature identification.

Module-2:

Fingerprint recognition: fingerprint sensing, acquisition devices, feature extraction, ridge orientation and frequency, segmentation, singularity detection, enhancement and binarization, minute extraction, matching approaches, palmprint features, finger print and palmprint recognition in forensics.

Module-3:

Face recognition: face recognition techniques, principal component analysis(PCA), eigenfaces, linear discriminant analysis(LDA) and fisherfaces, local face recognition and hybrid face recognition techniques, Ear as a biometric, approaches, PCA, force field transformation, acoustic ear recognition.

Module-4:

Iris recognition and vascular pattern recognition: typical iris recognition system, image acquisition, capturing devices, iris segmentation, segmentation using the integro-differential operator, segmentation using geodesic active contours, iris normalization, coordinate transformation, image enhancement, feature extraction, recognition, encoding and matching, performance evaluation, hand vascular pattern technology, operation, acquisition, feature extraction, pattern matching.

Module-5:

Gait and hand geometry: Gait recognition, segmentation of walking humans, detection and extraction algorithms, shadow removal, gait cycle detection, gait analysis for feature extraction, radon transform, gait recognition, hand geometry, image capture, processing steps, performance.

Course outcomes: After the completion of the course the students will be able to;

1. Express the importance of biometrics, operation of biometric systems, characteristics and performance of biometrics, forensic identification
2. Design and develop finger print recognition system, acquisition devices, segmentation algorithms, matching approaches, palm print sensing and recognition
3. Explain and interpret face recognition system, acquisition devices, algorithms, and ear biometric recognition system

4. Describe iris recognition system, acquisition devices, algorithms, encoding and matching, hand vascular pattern acquisition and recognition
5. Explain and interpret gait and hand biometric system, acquisition, processing algorithms, feature extraction and matching.

Reference Books :

1. Hand Book of Biometrics: Anil K. Jain, Patrick Flynn, Arun A. Ross, Springer, 2008 (ISBN: 978-0-387-71040-2) .
2. Signal and Image Processing for Biometrics: ed. Amine Nait-Ali and Regis Fournier, Wiley 2012, (ISBN: 978-1-84821-385-2).
3. Guide to Biometrics, Ruud M. Bolle, Jonathan H. Connel, Sharath Pankanti, Nalini K Ratha, Andrew W Senior, Springer, 2009 (ISBN: 0387400893).

WAVELET TRANSFORMS AND APPLICATIONS					
Subject Code	**:**	**18LBI322**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 04**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**50**	**Exam Hours**	**:**	**03**

Each Module 10 Hrs

Course Objectives:

1. To understand the fundamental concepts wavelet transform in advanced signal processing.
2. To know the need and importance of time-frequency analysis and apply wavelet transform for necessary applications.

Module-1:

Continuous Wavelet Transform: Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT.

Module-2:

Discrete wavelet Transform: Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT.

Module-3:

Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two dimensional wavelet transform.

Module-4:

Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary.

Module-5:

Applications: Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signaling pulses, Discrete Wavelet Multitone Modulation.

Beyond Wavelet: Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications.

Course Outcome: After successful completion of this course, students should able to;

1. Classify various wavelet transform and explain importance of it.
2. Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).
3. Explain the properties and application of wavelet transform.
4. Develop and realize computationally efficient wavelet based algorithms for signal and image processing.
5. Explain brief features and strength of transform beyond wavelet.

Reference Books:

1. Wavelet Transforms –Introduction and applications - Raguveer M. Rao and Ajit S. Bopardikar- -Pearson Education, 2008
2. Insight into Wavelets from Theory to practice - K.P Soman, K. I. Ramachandran, PHI, 2006
3. Fundamentals of Wavelets: Thory, Algorithms and Applications- J C Goswamy and A K Chan, Wiley- Inderscience Publications, John Wiley and Sons, 1999.

BIOMECHANICS AND REHABILITATION ENGINEERING					
Subject Code	**:**	**18LBI323**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 04**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**50**	**Exam Hours**	**:**	**03**
Each Module 10 Hrs					

Course Objectives:

1. To understand the fundamentals of human motion and factors influencing the motion
2. To understand the basics of orthotic and prosthetic devices, and mobility aids used in the physical rehabilitation.

Module-1:

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.

Module-2:

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.

Module-3:

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.

Force Platform and Kinematic Analysis: Design of force platforms, Integrating force and Kinematic data; linked segment, free-body analysis.

Module-4:

Orthotic Devices in Rehabilitation Engineering:

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Biomechanics of orthoses, merits & demerits of orthotics, Material design consideration in orthotics, Calipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacroorthosis, Splints-its functions & types.

Module-5:

Prosthetic Devices: Introduction, Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction Mechanisms, Extension aid, Stabilizers, Socket. Disarticulation Prostheses, Knee Disarticulation Prostheses, Hip Disarticulation Prostheses

Mobility Aids: Walking frames, Parallel bars, Rollators, Quadripods, Tripods & walking sticks, Crutches, Wheel chairs

Course Outcomes: After successful completion of this course, students should able to;

1. Describe the mechanics of moving systems and competently analyze gross movement of the human body.
2. Analyze computationally the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture (gait) and force platform systems.
3. Discuss the design process and working of orthotic and prosthetic devices and mobility aids.

Reference Books:

1. "Joint Structure and Function, A Comprehensive Analysis", Pamela K. Levangie and Cynthia C. Norkin, JAYPEE Publications, Fourth Edition, 2006.
2. "Biomechanics; Mechanical Properties of Living Tissues", Y. C. Fung Springer Verlag, 1985.
3. "Biomechanics, Structures and Systems", A. A. Biewener, Sports Publication
4. "Biomechanics of Human Motion", T. McClurg, Anderson.
5. "Rehabilitation Medicine" - By Dr. S. Sunder, 2nd Edition, Jaypee Medical Publications, Reprint 2004.
6. "Physical Rehabilitation" - by Susan B O'Sullivan, Thomas J Schmitz. 5th Edition, Jaypee Pub.,2007.

MEDICAL DEVICE REGULATIONS, IPR AND MEDICAL ETHICS				
Subject Code	**: 18LBI324**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

1. To understand the practical knowledge about medical regulations, standards and intellectual property, and their relationship to quality health care and associated biomedical technology.
2. To understand the theory and practice of medical ethics.

Module-1:

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.

Module-2:

Standards and Regulations Background

Standards: What are standards? Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations.

The ISO 9000 Series of Standards, The ISO 14000 Series of Standards, EN 46001, The ISO 13485 Standard, ISO 9000-3, IEC 601-1-4

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.

Module-3:

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.

Module-4:

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.

Module-5:

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

Course Outcomes: Upon completion of the subject, students will be able to:

1. Demonstrate understanding on how to the meet standards and regulatory requirements
2. Demonstrate understanding of the practical knowledge about intellectual property, such as patent, and understand the need and practice of medical ethics.

Text Books:

1. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006
2. Medical Device Quality Assurance and Regulatory Compliance Richard C Fries, CRC Press, 1998
3. "Intellectual Property Rights", Prabuddgha Ganguli, TMH Publishing Co. Ltd. 2001.

Reference Books:

1. World Intellectual Property Organizations (WIPO) Handbook/ Notes
2. Medical device regulations: global overview and guiding principles Michael Cheng, World Health Organization
3. Product Safety in the European Union Gábor Czitán, Attila Gutassy, Ralf Wilde, TÜV Rheinl and Akadémia, 2008
4. D.H. Lawerance, Chapter 2, Principles of biomedical ethics Jones & Bartlet publishers
5. "Intellectual Property Law Handbook, Dr. B. L. Wadhera, Universal Law Publishing Co. Ltd., 2002.

BIOSTATISTICS					
Subject Code	**:**	**18LBI331**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 04**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**50**	**Exam Hours**	**:**	**03**

Each Module 10 Hrs

Course Objectives:

1. This course aims to teach the students to organize and summarize data.
2. To teach the students how to reach decisions about a large body of data by examining only a small part of data.
3. To help the students to gain some mathematical ability in the area of probability and to assist them in developing an understanding of the more important concepts.
4. To help the students to gain the knowledge of the probability distribution of a random variable, which provides the clinician and researcher, with a powerful tool for summarizing and describing a set of data for reaching conclusions about a population of data on the basis of a sample of data drawn from the population.

Module-1:

Introduction to Biostatistics: Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and biostatistical analysis.

Descriptive Statistics: Introduction, ordered array, grouped data-frequency distribution, descriptive statistics – measure of central tendency, measure of dispersion, measure of central tendency computed from grouped data, variance and standard deviation-grouped data.

Module-2:

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.

Module-3:

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.

Module-4:

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.

Module-5:

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.

Course Outcomes: After the completion of this course the student will be able to;

1. Determine the nature of the biological information by applying the tools of statistics.
2. Distinguish between subjective and objective probability.
3. Differentiate between various distributions.
4. Discuss the difference between two sample proportions.
5. Determine the sample size needed to estimate a population mean and a population proportion at specified levels of precision.

Reference Books:

1. "Biostatistics-A Foundation for Analysis in the Health Sciences" Wayne W. Daniel, John Wiley & Sons Publication, 6th Edition.
2. "Principles of Biostatistics", Marcello Pagano and Kimberlee Gauvreu, Thomson Learning Publication, 2006.
3. "Introduction to Biostatistics" by Ronald N Forthofer and Eun Sul Lee, Academic Press
4. "Basic Biostatistics and its Applications" Animesh K. Dutta (2006)

ARTIFICIAL INTELLIGENCE AND PATTERN RECOGNITION					
Subject Code	**:**	**18LBI332**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 04**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**50**	**Exam Hours**	**:**	**03**

Course Objectives:

1. To teach introduction to basic concepts of pattern recognition and its methods.
2. To make the students become acquainted with automatic identification applying pattern recognition and the related technical aspects of data analysis in machine learning.

Module-1:

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

Probability: Introduction to probability, conditional probability, Random Variables, The Binomial and Poisson distribution, Joint Distribution and Density, Moments of Random Variables, Estimation of Parameters from Samples.

Module-2:

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

Module-3:

Maximum-likelihood and Bayesian Parameter Estimation: Introduction, Maximum-likelihood estimation; Bayesian Estimation; Bayesian parameter estimation: Gaussian Case, general theory; Hidden Markov Models.

Module-4:

Processing of waveforms and Images: Introduction, Gray Level Scaling Transformations, Equalization, Geometric Image Scaling and Interpolation, Smoothing Transformations, Edge Detections, Line Detection And Template Matching.

Module-5:

Clustering: Introduction, Hierarchical clustering, Partitional clustering.

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

Course Outcomes: After the completion of this course the student will be able to;

1. Explain the basic concepts of artificial intelligence and pattern recognition.
2. Design and evaluate Bayesian classification, algorithms, error rate of classifier, different methods, performance evaluation.
3. Design and develop clustering algorithms, and its different types, hierarchical and Partitional clustering algorithms.
4. Discuss the implementation of pattern recognition concepts in different biometric systems.

Reference Books:

1. Richard O. Duda, Peter E. Hart, and David G.Stork: Pattern Classification, 2nd Edition, Wiley-Inderscience, 2001.
2. Earl Gose, Richard Johnsonbaugh, Steve Jost: Pattern Recognition and Image Analysis, Pearson Education, 2007.
3. K. Jain, R. Bolle, S. Pankanti: Biometrics: Personal Identification in Networked Society, Kluwer Academic, 1999.

CLOUD COMPUTING				
Subject Code	**: 18LBI333**		**CIE Marks**	**: 40**
Hrs/Week & Credits	**: 04 & 04**		**SEE Marks**	**: 60**
Total Lecture Hours	**: 50**		**Exam Hours**	**: 03**

Each Module 10 Hrs

Course Objectives:

- To introduce the broad perceptive of cloud architecture and model
- To understand the concept of Virtualization
- To understand the features of cloud simulator
- To apply different cloud programming model as per need.
- To be able to set up a private cloud and design of cloud Services.
- To learn to design the trusted cloud Computing system

Module-1:

Cloud Architecture and Model: Technologies for Network-Based System – System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture. Cloud Models: Characteristics – Cloud Services – Cloud models (IaaS, PaaS, SaaS) – Public vs Private Cloud –Cloud Solutions - Cloud ecosystem – Service management – Computing on demand.

Module-2:

Virtualization: Basics of Virtualization - Types of Virtualization - Implementation Levels of Virtualization - Virtualization Structures - Tools and Mechanisms - Virtualization of CPU, Memory, I/O Devices - Virtual Clusters and Resource management – Virtualization for Data-center Automation.

Module-3:

Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development – Design Challenges - Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources.

Module-4:

Programming Model: Parallel and Distributed Programming Paradigms – Map Reduce, Twister and Iterative Map Reduce – Hadoop Library from Apache – Mapping Applications - Programming Support - Google App Engine, Amazon AWS - Cloud Software Environments - Eucalyptus, Open Nebula, Open Stack, Aneka, Cloud Sim .

Module-5:

Security in the Cloud: Security Overview – Cloud Security Challenges and Risks – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security - Identity Management and Access Control – Autonomic Security.

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

- Compare the strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept.
- Choose the appropriate cloud player
- Choose the appropriate Programming Models and approach.

- Address the core issues of cloud computing such as security, privacy and interoperability
- Design Cloud Services
- Set a private cloud

Reference Books:

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. John W. Rittinghouse and James F. Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
3. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009.
4. Kumar Saurabh, " Cloud Computing – insights into New-Era Infrastructure", Wiley India,2011.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'Reilly
6. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. Katarina Stanoevska- Slabeva, Thomas Wozniak, Santi Ristol, "Grid and Cloud Computing – A Business Perspective on Technology and Applications", Springer.
8. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
9. Rajkumar Buyya, Christian Vecchiola, S.Tamarai Selvi, 'Mastering Cloud Computing", TMGH,2013.
10. Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press, 2011

MODELLING AND SIMULATION IN BIOMEDICAL ENGINEERING					
Subject Code	**:**	**18LBI334**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 04**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**50**	**Exam Hours**	**:**	**03**

Each Module 10 Hrs

Course Objectives:

1. To understand the importance of modeling of different type of signals
2. To study the different modeling techniques applied to biomedical systems.

Module-1:

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.

Module-2:

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.

Module-3:

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.

Module-4:

Nonlinear 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.

Module-5:

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.

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

1. Discuss the modeling concepts in continuous and discrete time signals.
2. Describe different techniques in modeling stochastic signals.
3. Develop models of different biomedical system with different modeling techniques.

Reference Books:

1. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling" John Wiley & Sons, Inc, reprint 2009 (Chapters I-IV).
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", John Wiley & Sons, Inc, reprint 2000, (Chapter- V)

M.Tech. : BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

Outcome Based Education (OBE) and Choice Based Credit System (CBCS): 2018-19

SYLLABUS – IV SEMESTER

PROJECT WORK PHASE -2					
Subject Code	**:**	**18LBI41**	**CIE Marks**	**:**	**40**
Hrs/Week & Credits	**:**	**04 & 20**	**SEE Marks**	**:**	**60**
Total Lecture Hours	**:**	**56**	**Exam Hours**	**:**	**03**

Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior Faculty Member of the Department. The CIE marks awarded for Project Work Phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.