VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Biomedical Signal Processing and Instrumentation
(Effective from the Academic year 2022-23)

Registrar,
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M.TECH IN BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION(LBI)

Semester – 1

Advanced Mathematics			
Course Code	22LBI11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students:

- To familiarize the important tools of Linear algebra, that are essential in Electronics and communication engineering.
- To develop the knowledge/skills of probability theory in a comprehensive manner.

At the end of the course, students are able to:

1. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
2. Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
3. Analyze and solve inner products, orthogonality, gram-Schmidt process, QR factorization, least squares problems.
4. Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
5. Analyze random process through parameter-dependent variables in various random processes.

Module-1	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. David C.Lay, Steven R.Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015
2. Scott L.Miller,Donald G.Childers: "Probability and Random Process with application to Signal Processing", Elsevier Academic Press, 2 nd Edition,2013.Gilbert Strang: Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press.,2016
3. T.Veerarajan "Probability, Statistics and Random Process", 3rd Edition, Tata Mc-Graw Hill Co.,2016.

Web links and Video Lectures (e-Resources):

1. http://nptel.ac.in/courses.php?disciplineId=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://ocw.mit.edu/courses/mathematics/
4. www.wolfram.com

Skill Development Activities Suggested

Practice more number of complex problems

Course outcome (Course Skill Set)

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

Course outcomes:

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

1. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
2. Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.
3. Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
4. Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.
5. Analyze random process through parameter-dependent variables in various random processes.

Biomedical Signal Processing			
Course Code	**22LBI12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

1. Develop an interest to simulate the models and validate its functionality in real time systems.
2. Demonstrate an ability to integrate different concepts to develop new models that suits current trends
3. To understand the time domain and frequency domain algorithm

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-2

ECG Data
Transfor

DPCM, H
Signal A
limitatio

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-3

Frequency Domain Analysis: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artefacts (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 modelling and analysis of PCG signals.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

MODULE-4

Spectral Estimation: Introduction, Blackman- Tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony's 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Write a program in C / Matlab to display an static and moving ECG signal
2	Write a program in C / Matlab to detect the alpha and beta rhythms in EEG signal
3	Write a program in C / Matlab to implement the Huffman coding
4	Write a program in C / Matlab to compress the signal using DPCM
5	Write a program in C / Matlab to implement the AR / MA / ARMA models
6	Write a program in C / Matlab to display the cepstrum of an EEG signal
7	Write a program in C / Matlab to implement the Homomorphic filter
8	Write a program in C / Matlab to display the Welch periodogram for an ECG signal
9	Write a program in C / Matlab for correlation analysis of an EEG signal
10	Write a program in C / Matlab to implement the adaptive filter algorithms (LMS / RLS)
11	Design and rig up the circuit to acquire the ECG, EMG and EEG signals.
12	Testing hearing ability and air conduction thresholds using audiometer and plotting of audiogram.

Assessment Details (both CIE and SEE)

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CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**

2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

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.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Mini project in the area of biomedical signal processing using modern tools like MATLAB, Python, scilab

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the acquisition of Biomedical Signals	L1 L2
CO2	Able to implement data compression techniques and signal averaging	L3
CO3	Able to analyze the frequency analysis and time series analysis	L4
CO4	Able to understand parametric & non-parametric methods for power spectrum estimation..	L1
CO5	Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.	L2 L3

Modern Bio-Medical Instrumentation			
Course Code	**22LBI13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 slots for Skill Development Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

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.

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 artefacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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. Lithotripters- principle, modern lithotripter-block diagram and working. Anaesthesia-Need for anaesthesia, delivery of anaesthesia, anaesthesia machine. Infusion pumps-principle and programmable volumetric infusion pump.	
Teaching-Learning	Chalk and Talk / Power Point Presentations.

Process	

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books :

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

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Mini project in group wise on design of biomedical instrumentation systems

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the sources of biomedical signals.	L2

CO2	Able to understand and implement biomedical recording systems and recorders	L2 L3
CO3	Able to analyze patient monitoring systems	L3
CO4	Able to understand and analyze blood flow meters and cardiac equipments	L2 L3
CO5	Able to understand respiratory and therapeutic equipments	L2

Human Physiology			
Course Code	**22LBI14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours Theory + 10-12 slots for Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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, Haemorrhage.

Teaching-Learning Process	. Chalk and Talk / Power Point Presentations.

Module-3

GIS: GIS, Functions of stomach, pancreas, liver, intestine, function tests: endoscopies.
Nervous System : Introduction to nervous system, Neuron, Classification of nerve fibres, Properties of nerve fibres, Degeneration & regeneration of nerve fibres, Neuroglia, Receptors, Synapse, Neurotransmitters, Reflex activity, Physiology of pain, Hypothalamus, Electroencephalogram.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses
- https://en.wikibooks.org/wiki/Human_Physiology

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to remember and understand general physiology	L1 L2
CO2	Able to understand the cardiovascular system and nervous system	L2
CO3	Able to analyze physiology of sleep, epilepsy, cerebral circulation and tests	L4

Medical Imaging Systems			
Course Code	**22LBI15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours Theory + 10 -12 slots for Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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.

Module-1

X-Ray and Radiography: 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-Ray detectors, Conventional X-Ray radiography, Fluoroscopy, Angiography, Digital radiography, X-Ray image characteristics, Biological effects of ionizing radiation.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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 – pyroele ctric vidicon camera clinical thermography – liquid crystal thermography.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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 Imaging system, Slice selection, Frequency encoding, Phase encoding, Spin-Echo imaging, Gradient-Echo imaging, Imaging safety, Biological effects of magnetic field, Introduction to Functional MRI.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks:

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. The physics of medical imaging, Steve Webb, 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

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Visiting multi speciality Hospital
- Visiting the biomedical companies

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand medical imaging systems like radiography x - ray	L2
CO2	Able to understand and analyze CT scan systems and reconstruction algorithms	L2 L4
CO3	Able to analyze radio nuclide imaging systems, ultrasound imaging and MRI	L4

Research Methodology and IPR			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3. Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
4. Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
5. Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR

Module-1	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1.The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3.Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4.Each full question will have a sub-question covering all the topics under a module.
5.The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Textbooks:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International,4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications,3rd Edition, 2011.
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
4. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
5. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Skill Development Activities Suggested:

1) Interact with industry (small, medium, and large).
2) Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3) Involve in case studies and field visits/ fieldwork.
4) to the use of standards/codes etc., to narrow the gap between academia and industry.
5) Handle advanced instruments to enhance technical talent.
6) Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7) Accustom Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem.	L1, L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1, L2
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L1, L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports.	L1, L2, L3
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	L1, L2, L3, L4

Bio-Medical Signal Processing Lab			
Course Code	**22LBI17**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To understand the Matlab programming techniques
- To understand the various signal processing algorithm

Sl.NO	Experiments
1	Develop Matlab programs to perform convolution, correlation and FFT.

2	Develop Matlab programs to implement FIR filters and IIR filters
3	Develop Matlab programs for Spectral Modeling and Analysis of ECG Signals
4	Develop Matlab programs for Detection of QRS complex and heart rate measurement.
5	Develop Matlab programs for Auto-correlation and cross correlation of ECG signals.
6	Develop Matlab programs for Signal Averaging to improve the SNR.
7	Develop Matlab programs for Design of 50 Hz notch filter for ECG signal and display PSD.
8	Develop Matlab programs for Data Compression Techniques: AZTEC, TP, FAN algorithms.
9	Develop Matlab programs for Design of Wiener Filter to remove Artifacts in ECG Signal.
10	Develop Matlab programs for Design of Adaptive Noise Canceller for the removal of Interference and Noise in Bio signals.
	Demonstration Experiments (For CIE) if any
11	Conduct experiments to measure (i) Blood Pressure using sphygmomanometer and automated system, and (ii) Heart rate and Heart sounds using Phonocardiograph.
12	Design and implementation of circuits with biomedical applications (like QRS detector, ECG Amplifier, EMG amplifier, Instrumentation amplifier)
13	Study and acquisition of PPG and Realization of a Pacemaker circuit.
14	Study and acquisition of PPG and Realization of a Pacemaker circuit.

Course outcomes (Course Skill Set):

At the end of the 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.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

www.mathworks.com

Sl No.	Course Code	Course Title	National Coordinator
1	22AUD18		NPTEL

	/22AEC18	Electrocardiogram - Interpretation and application in clinical practice	
2	22AUD18 /22AEC18	Patent Law for Engineers and Scientists	NPTEL
3	22AUD18 /22AEC18	Advanced Engineering Mathematics	NPTEL
4	22AUD18 /22AEC18	Introduction to Biomedical Imaging Systems	NPTEL
5	22AUD18 /22AEC18	Digital Image Processing	NPTEL
6	22AUD18 /22AEC18	Biomedical nanotechnology	
7	22AUD18 /22AEC18	Digital Speech Processing	NPTEL
8	22AUD18 /22AEC18	Photonics	NPTEL

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):

Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

M.TECH IN BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION(LBI)

Semester 2

Advanced Digital Image Processing			
Course Code	22LBI21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities.	Total Marks	100

Credits	03	Exam Hours	03

Course Learning objectives:

- **To understand fundamentals of basic digital image processing**
- **To implement the digital image processing algorithms**

Module-1

Fundamentals of Digital Image Processing: 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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 descript ors, texture.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

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Suggested Learning Resources:

Textbooks:

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.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Mini project in the area of advanced digital image processing using modern tools like MATLAB, Python, scilab

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the acquisition of digital images	L1 L2
CO2	Able to implement the image compression techniques	L3
CO3	Able to understand and analyze the image segmentations techniques	L2 L4
CO4	Able to understand morphological image processing	L1 L2

Speech Signal Processing			
Course Code	**22LBI22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- To understand the digital models for speech signals
- To analyze and implement the time domain and frequency domain of speech signals

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	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
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.	

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl.NO	Experiments
1	**Write a program in Matlab to record the speech signal**
2	**Write a program in Matlab to compute the short time Energy and average magnitude of a speech signal**
3	**Write a program in Matlab to compute the pitch period estimation of a speech signal**
4	**Write a program in Matlab to implement delta modulation**
5	**Write a program in Matlab to implement DPCM**
6	**Write a program in Matlab to demonstrate the frequency analysis of speech signal**
7	**Write a program in Matlab to implement the linear predictor algorithm for two numbers**
8	**Write a program in Matlab to synthesize the speech signal**
9	**Write a program in Matlab to implement the text to speech conversion**
10	**Write a program in Matlab to implement speech recognition algorithm**
11	**Demo on speech signal recording using Simulink model**
12	**Demo on speech recognition using Simulink model**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**

2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Textbooks:

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

Web links and Video Lectures (e-Resources): **https://www.mooc.org/** **https://onlinecourses.nptel.ac.in/**
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning **Mini project in the area speech signal processing using modern tools like MATLAB, Python, scilab**

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the sources of speech signal models	L2
CO2	Able to understand and implement the short time Fourier transform on speech signals	L2 L3
CO3	Able to analyze the digital representation of signals	L4
CO4	Able to understand and analyze prediction algorithms for speech signals	L2 L4
CO5	Able to analyze the speech synthesis and speech recognition models	L3

Photonics for Medical imaging			
Course Code	22LBI231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze the photonics in Medical Imaging
- To understand the various applications of optical biosensors

Module-1

Basic of Lasers: Principles of Lasers, Current Laser Technology, and Nonlinear Optics: Principles of Lasers, Principles of Laser Action, Classification of Lasers, Some Important Lasers for Bio-photonics Current Laser Technologies, Quantitative Description of Light: Radiometry, Nonlinear Optical Processes with Intense Laser Beam, Mechanism of Nonlinear Optical Processes, Frequency Conversion by a Second-Order Nonlinear Optical Process, Symmetry Requirement for a Second-Order Process, Frequency Conversion by a Third-Order, Nonlinear Optical Process, Multiphoton Absorption, Time-Resolved Studies, Laser Safety.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Bio-imaging: Principles and Techniques: An Overview of Optical Imaging, Transmission Microscopy, Simple Microscope, Compound Microscope, Kohler Illumination, Numerical Aperture and Resolution.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
Optical Bio-microscopic Imaging: Optical Aberrations and Different Types of Objectives, Phase Contrast Microscopy, Dark-Field Microscopy, Differential Interference Contrast Microscopy, Fluorescence Microscopy, Scanning Microscopy, Confocal Microscopy, Multi-photon Microscopy. Optical Coherence Tomography, Total Internal Reflection Fluorescence Microscopy, Near-Field Optical Microscopy, Spectral and Time Resolved Imaging, Spectral Imaging , Band pass Filters, Excitation Wavelength Selection, Acousto-Optic Tuneable Filters, Localized Spectroscopy, Fluorescence Resonance Energy Transfer (FRET) Imaging, Fluorescence Lifetime Imaging Microscopy (FLIM), Nonlinear Optical Imaging, Second-Harmonic Microscopy, Third-Harmonic Microscopy, Coherent , Anti-Stokes Raman Scattering (CARS) Microscopy, Multifunctional Imaging, Pi Imaging, Combination Microscopes, Miniaturized Microscopes, Some Commercial Sources of Imaging Instruments.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
Applications of Bio-photonics: Fluorophores as Bio-imaging Probes, Organometallic Complex Fluorophores, Near-IR and IR Fluorophore, Two-Photon Fluorophores, Inorganic Nanoparticles, Green Fluorescent Protein, Imaging of Organelles, Imaging of Microbes, Confocal Microscopy, Near-Field Imaging, Cellular Imaging, Probing Cellular Ionic Environment, Intracellular pH Measurements, Optical Tracking of Drug-Cell Interactions, Imaging of Nucleic Acids, Cellular Interactions Probed by FRET/FLIM Imaging, Tissue Imaging, In Vivo Imaging, Commercially Available Optical Imaging Accessories	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	
Optical Biosensors: Principles of Optical Bio-sensing, Bio-recognition, Optical Transduction, Fluorescence Sensing, Fluorescence Energy Transfer Sensors, Molecular Beacons, Optical Geometries of Bio-sensing, Support for and Immobilization of Bio-recognition Elements. Immobilization, Planar Waveguide Biosensors, Evanescent Wave Biosensors, Interferometry Biosensors, Surface Plasmon Resonance Biosensors, Some Recent Novel Sensing Methods, Commercially available sensors.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Textbook:

1. Introduction to Bio-photonics, Paras N Prasad, A John Wiley & Sons, Inc., Publication. 2003.
2. Fundamentals of Light Microscopy & Electronic Imaging, Douglas B Murphy, John Wiley & Sons, 2001.
3. Biomedical Optics: Principles and Imaging, Lihong V Wang, Hsin-I Wu, May 2007.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to remember and understand basics of laser	L1 L2
CO2	Able to understand the optical imaging	L2
CO3	Able to analyze the applications of biophotonics	L4

Medical Informatics & Expert systems			
Course Code	**22LBI232**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze hospital management
- To understand and analyze telecommunication in medical systems

Module-1

Medical Informatics: Aim and scope, salient feature, Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics. **Hospital Management And Information Science**: Introduction, HMIS: need, Benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMIS-client server technology, PACS, why HMIS fails, health information system, disaster management plans, advantages of HMIS.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Hospital Management And Information Systems-Structure And Functions : Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module, Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Examination, Account Billing, Medical Research, Communication, General Information.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring. **Computer Assisted Patient Education:** CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	
Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications. **Tele-Surgery:** Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Textbook:

1. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.
2. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2nd Edition, Springer Verlag, 2000.
3. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Seminar activities

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand medical informatics in hospital	L2

CO2	Able to understand and analyze hospital management and its functions	L2 L4
CO3	Able to analyze knowledge based systems and expert systems	L4
CO4	Able to understand and analyze the telecommunication based systems	L2 L4

Neural Network & Fuzzy logic in Medicine			
Course Code	**22LBI233**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze the neural network systems in medicine
- To understand and analyze the fuzzy logic systems in medicine

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Fuzzy Rule based system Linguistic Hedges. Rule based system, Graphical techniques for Inference, Fuzzification and Defuzzification, fuzzy additive models Applications.
Case studies: Fuzzy logic control of Blood pressure during Anaesthesia, Fuzzy logic application to Image processing equipment, Adaptive fuzzy system.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Textbooks:

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

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Mini project group wise on neural network and fuzzy logic algorithms
- Experiments to conduct Neuro-fuzzy logic tool using Lab View software

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to analyze and implement neural network algorithms	L4
CO2	Able to understand and implement the support vector machine algorithm for classification	L2 L3
CO3	Able to understand and analyze fuzzy logic based system	L2 L4

Statistical Signal Processing			
Course Code	**22LBI234**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze the parametric method and non parametric methods
- To understand and analyze the adaptive filter algorithms

Module-1	
Digital Filter design using least-square method: Least Square error criterion in the design of Pole-zero filters, FIR least squares inverse filters.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-2	
Spectral Estimation and Analysis -Non parametric methods: Periodogram, Bartlett and Welch modified periodogram, Blackman-Tukey Methods.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-3	
Spectral estimation and analysis -Parametric methods: wide sense stationary random process, rational power spectra: Auto Regressive (AR) Process, Moving Average (MA) Process, ARMA Process, Relationship between the Filter Parameters and the auto correlation sequence.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-4	
Forward and backward Linear Prediction: Forward Linear Prediction, Backward Linear Prediction, Relationship of an AR process to Linear Prediction: Yule– Walker Method, Levinson– Durbin Algorithm.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.
Module-5	

Adaptive Algorithms to adjust coefficients of digital filters: Least Mean Square (LMS), Recursive Least Square (RLS) and Kalman Filter Algorithms	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

Textbooks:

1. Statistical signal processing and Modelling, Monson H.Hayes, Wiley, 1996
2. Fundamentals of statistical signal processing, Estimation Theory, S.M.Kay, Prentice Hall, 1993
3. Digital Signal Processing, Principles, Algorithms, and Applications, Proakis, John G., Dimitris G. Manolakis, and D. Sharma:, Pearson Education, 2006.
4. Digital Signal Processing a computer Based approach, Mitra Sanjit.K, Tata McGraw Hill, 2001.
5. Adaptive Signal Processing, B. Widrow & S Stearns, PHI, 1985.
6. Statistical and Adaptive Signal Processing, Dimitris, Manolakis, McGraw Hill, 2000.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand and implement the digital filter design and least square sense	L2 L3
CO2	Able to understand and implement the parametric and non parametric methods of spectral estimation	L2 L3
CO3	Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm	L4
CO4	Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.	L2 L4

Advanced Bio-medical Signal Processing			
Course Code	**22LBI235**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand and analyze Kalman filter and signal classification
- To understand and analyze the wavelet transform and its applications

Module-1

Analysis of Nonstationary and Multicomponent Signals : Illustration of the problem with case studies, Heart sounds and murmurs, EEG rhythms, Time variant systems, Fixed segmentation, Adaptive segmentation, Adaptive filters for segmentation. Application : Adaptive segmentation of EEG and PCG , Time varying analysis of HRV

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Kalman Filter : Introduction, Dynamical signal models, scalar kalman filter, kalman versus Wiener filters, vector Kalman filter, Extended Kalman filter, Signal processing examples, Vector Kalman filter derivation, Extended Kalman filter derivation.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Signal Classification and recognition : Introduction, statistical signal classification, Linear discriminant functions, Fisher's linear discriminant, Karhunen – Loeve expansions, Direct feature selection and ordering

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Wavelet Detection : Introduction, detection by structural features, simple structural algorithms, contour limiting , matched filtering, Adaptive wavelet detection, template adaptation, tracking a slowly changing wavelet, correction initial template, detection of overlapping wavelets, statement of the problem, initial detection and composite hypothesis formulation, error criterion and minimization.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Fast algorithms for wavelet transform computation : Introduction, multi resolution and two scale equations, the initial signal approximation, DWT, the DWT for WS and CWT computation, efficient implementations of the DWT, Faster DWT algorithms, other algorithms for CWT computation.

Wavelet Feature Extraction from Neuro physiological Signals : Introduction, Signal – to – Noise Ratio, wavelet spectral division, variance, Spectral features in the wavelet extrema and zero crossings, computation experimental results

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

1. Biomedical Signal Analysis Second Edition by Ragaraj M Rangayyan IEEE PRESS Wiley
2. Biomedical Signal Processing VOL II Compression and Automatic Recognition by Arnon Cohen
3. Biomedical Signal Processing and Signal Modelling by Eugene N Bruce
4. Fundamentals of Statistical Signal Processing : Estimation Theory by Steven M Akay
5. Time Frequency and Wavelets in Biomedical Signal Processing IEEE PRESS Edited by Metin Akay
6. Biomedical Signal Processing by Metin Akay Academic Press, INC

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Mini project in the area of advanced biomedical signal processing using modern tools like MATLAB, Python, scilab

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to analyze the non stationary signals	L4
CO2	Able to understand the Kalman filter model	L2
CO3	Able to understand the signal classification of signals	L2
CO4	Able to understand and analyze the wavelet transform and its applications	L2 L4
CO5	Able to understand and implement the fast wavelet transform	L2 L4

Bio-materials and Artificial Organs			
Course Code	**22LBI241**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the biomaterials and its uses in medical applications
- To understand the artificial organs and its uses

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Implant Materials

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Polymeric Implant Materials

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Artificial Organs

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Textbooks:

1. Sujata V. Bhat, 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 Enginee ring & Design", McGraw-Hill, 2003.
5. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2005.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Visiting biomedical companies to know about practical aspects

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the structure of bio materials	L2
CO2	Able to understand and analyze the tissue replacement implants	L2 L4
CO3	Able to understand and analyze the artificial organs	L2 L4

Wireless Technologies for Medical Applications			
Course Code	**22LBI242**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the various wireless networks
- To understand and analyze the applications of wireless networks in medicine

Module-1	
Fundamentals of Wireless Communication: Digital Communications, Wireless Communication System, Wireless Media, Frequency Spectrum, Technologies in Digital wireless Communication, Coding, Types of Wireless Communication Systems.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2	
Wireless Body Area Network (WBAN): Network Architecture, Network Components, Design Issues, Network Protocols, WBAN Technologies, WBAN Applications.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3	
Wireless Personal Area Networks: Wireless Personal Area Network (WPAN) , Network Architecture, WPAN Components, WPAN Technologies and Protocols, WPAN Applications.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4	
Wireless Local Area Networks: Network Components, Design Requirements of WLAN, Network Architecture, WLAN Standards, Case studies in biomedical domain.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5	
Applications of Wireless Sensor Networks: Introduction, Background Examples of Category of WSN Applications Home Control, Building Automation, Industrial Automation, Medical Applications, Case studies in biomedical domain.	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

1. Wireless and Mobile Networks, Concepts and Protocols, Sunilkumar S. Manvi , Mahabaleshwar S. Kakkasageri ,2nd Edition, 2016, ISBN-13: 978-8126520695.
2. Fundamentals of Wireless Sensor Networks: Theory and Practice, Waltenegus Dargie, Christian Poellabauer, Willey Publications, ISBN-13: 978-8126551255
3. Wireless Communications & Networks, William Stalling Pearson 2nd Edition, ISBN 978-8132231561.
4. Wireless Communication – Principles & Practice , T. S. Rappaport ,Pearson 2nd Edition, 2010. ISBN-13: 978-8131731864.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- **Mini project in the area of wireless technologies using modern suitable tools**

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the fundamentals of wireless communication	L2
CO2	Able to understand and analyze the network architecture	L2 L4
CO3	Able to understand and analyze the applications of wireless sensor networks	L2 L4

ARM Embedded System Design			
Course Code	**22LBI243**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Discuss the ARM embedded systems and ARM processor
- Understand the ARM processor instruction set

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

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.

Teaching-Learning	Chalk and Talk / Power Point Presentations.

Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Textbooks:

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. Embedded Systems, Rajkamal, Tata McGraw-Hill publishers, 2008, ISBN:0070494703.
4. ARM System on chip Architecture Addison Wesley, Formatted: paperback, 2008, ISBN:978-0201675191.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

Mini project on any interfacing of peripherals using ARM processor

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the embedded systems	L1 L2
CO2	Able to understand and implement the ARM processor architecture and instruction set	L1 L2 L3
CO3	Able to analyze and apply the ARM processor interrupt handling	L3 L4
CO4	Able to understand and analyze the embedded operating systems	L2 L4

Advanced Clinical Instrumentation			
Course Code	**22LBI244**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Describe the Medical equipments in detail
- Understand the biomedical equipments troubleshooting

Module-1

ICU Equipment's and Neonatal Equipment: Oxygen concentrators – Capnographs monitoring systems - cardiac monitor, multipara monitor - Advanced defibrillators –internal and external – Intermediate level of suction apparatus – Laryngoscope - Advance level of radiant warmer, phototherapy units - Doppler fetal heart rate device (handheld type), Fetal Tocography, Baby Incubator, Neonatal ventilator

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Diagnostic Equipment's: Stereo toxic unit- depth recording system-dot scanners- transcutaneous nerve Stimulator-anaesthesia monitor - EEG controlled anaesthesia- bio-feedback equipments, Spinal reflex measurements. Basic Blood gas analyzer - Photometer and spectrophotometer - Microtome, osometer, Lab freezer - PH meter, Optical microscope - Water bath types, Centrifuge (table), Shakers, Lab, laminar air flow units - Lab precision balances, Pippets, Washers, Incubator and Heating unit centrifuge (Flour) – Electrophoresis systems, tissue embedding equipment - Ambulance setup.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Surgical Equipment's: Warmer (Blood and Patient) - tourniquet, insufflators, irrigation unit - Operating microscope - arthroscopic, Operation Theater (OT): Lights, and Patient's tables - Flow meters (gas & blood), sterilizing units (auto clave), Surgical driller - Sterilizing producers, manifold unit – Central supply of air. Laparoscope, Gastro scope, endoscopes -light sources. Bronchoscope: Video processors, Camera, and Fiber optic cable. Physiological effects of stimulation, galvanic, Faradic and surged types, interferential therapy.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Fundamental Troubleshooting Procedures: Making of an Electronic Equipment, causes of Equipment Failure, Troubleshooting Process & Fault finding Aids, Troubleshooting Techniques, Grounding Systems in Electronic Equipment, Temperature Sensitive Intermittent Problems, and Correction Action to repair the Equipment.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Biomedical Equipment Troubleshooting: Trouble shooting of ECG Machine, EEG Machine, Defibrillator Electrosurgical unit, Anaesthesia machine, Autoclaves & sterilizers, Endoscope. Troubleshooting of Incubators, Nebulizer, Oxygen Concentrators, Oxygen cylinders & flow meters, Pulse Oximeter, Sphygmomanometers, Suction Machine, X-Ray Machine Troubleshooting.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

8. Three Unit Tests each of **20 Marks**
9. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

Textbooks:

1. Albert M, Cook and Webster J G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1982.
2. Geddes L A and Baker L E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1975, Reprint 1989.
3. Khandpur R S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.
4. Khandpur R S, "Troubleshooting Electronic Equipment- Includes Repair & Maintenance", Tata McGraw-Hill, Second Edition 2009.
5. Dan Tomal & Neal Widmer, "Electronic Troubleshooting", McGraw Hill, 3rd Edn.
6. Leslie Cromwell, Fred J, Weibell, Erich A, Pfeiffer, "Biomedical Instrumentation andMeasurements", Prentice-Hall India, 2nd Edition,1997.
7. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition, 1997.
8. Feinberg B N, "Applied Clinical Engineering", Prentice Hall Inc., New Jersey, 1986.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Visiting multi speciality hospital
- Visiting biomedical companies

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe about various neonatal and ICU equipment's	
CO2	Analyze different types Diagnostic devices	
CO3	Understand fundamental troubleshooting procedures for biomedical instruments	

Ergonomics			
Course Code	**22LBI245**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of Teaching and 10 to 12 sessions of Skill Development Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Describe the design of work places
- To understand working hours and eating habits
- To understand and analyze the man machine systems

Module-1

The Design of Work Places: Working heights, Room to grasp and move things, Seating at work. **Heavy Work:** Physiological principles, Energy consumptions at work, Limits and norms of energy consumption at work, Organization of heavy work. **Handling loads:** Lifting, Carrying a burden.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-2

Skilled work: Acquiring skill, Maximum control of skilled movements, Facilitating skilled work.
Mental activity: Uptake of information, Memory, Sustained alertness.
Fatigue: Fatigue in industrial practice, Measuring fatigue.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-3

Boredom: Boredom from the standpoint of psychology, Problems of monotonous, repetitive work.
Working hours and eating habits: Flexible and continuous working schedules, Rest pauses, Nutrition and work.
Night work and shift work: Night work and health, Organization of shift work.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-4

Man – machine systems: Visual perception, Perception of sound, Display equipment, Controls, Relationship between controls and display instruments.
Light and colour in surroundings: Light measurement and light sources, Physiological requirements of artificial lighting, Lighting for the work place, Daylight, Colour in the work room.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations.

Module-5

Noise and Vibration: Measurement and sources of noise, Damage to hearing through noise, Physiological and psychological effects of noise, Protection against noise, Music and work, Vibrations.
Indoor climate: Thermal regulation in man, Comfort, Dryness of the air during heating periods, Recommendations for comfort indoors, Air pollution and ventilation, Heat in industry.

Teaching-Learning	Chalk and Talk / Power Point Presentations.

Process	

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Text Book:

1. Fitting the Task to the Man – An ergonomic approach, by E. Grandjean, 3rd Edition, Taylor & Francis Ltd, London.
2. Fitting the Task to the Human - A Text Book of Occupational Ergonomics by H. E. Kroemer and Etienne Grandjean, 5th Edition, Taylor & Francis Ltd, London.
3. Human Factors in Engineering and Design - by Mark S. Sanders and Ernest J. McCormick, 1993.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/

https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Visiting multi speciality hospital
- Visiting biomedical companies

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand, analyze and design of work place	L1 L2 L4 L6
CO2	Able to understand the working hours and eating hours	L1 L2
CO3	Able to analyze the man machine systems	L4
CO4	Able to evaluate the noise and vibration in work place	L5

MINI PROJECT WITH SEMINAR			
Course Code	**22LBI25**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:4:2)	SEE Marks	-
Total Hours of Pedagogy	30 hours Practical+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging thesources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini Project With Seminar: This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc. Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

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

1. Present the mini-project and be able to defend it.
2. Make links across different areas of knowledge and to generate, develop and evaluate ideas andinformation so as to apply these skills to the project task.
3. Habituated to critical thinking and use problem solving skills.
4. Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.5.Work in a team to achieve common goal.
6. Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio **50:25:25**. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester.

There is no SEE for this course. **RBT Level: L3, L4, L5, L6**

Speech and Digital Image Processing Lab			
Course Code	**22LBIL26**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To learn the programming skills
- To learn the Matlab software

Sl.NO	Experiments
1	To record, store and display the speech data using standard experimental setup.
2	To conduct a suitable experiment to determine the Pitch (time domain) and formant frequencies.
3	Examine effect of window shape and duration on energy, autocorrelation or speech spectrogram.
4	To conduct a suitable experiment to determine LPC using autocorrelation and covariance method
5	To develop a suitable program for analyzing voiced/ unvoiced detector.
6	To determine Spectrogram of speech signals.
7	Determine the minimum prediction error co-efficient of speech signal.
	Image Processing:
8	Medical Image enhancement – (Histogram based)
9	Medical Image smoothing.
10	Medical Image sharpening.
11	Algorithm for low pass filter, high pass filter, median filter.
12	Point detection, Line detection, Edge detection (Masks operations).
13	Medical Image Segmentation (Water shed segmentation; Fuzzy k means clustering).
14	Medical Image Restoration.
15	Medical Image denoising using Wavelet transform.

Course outcomes (Course Skill Set):

At the end of the 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.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources: www.mathworks.com

Sl No.	Course Code	Course Title	National Coordinator
1	22AUD27	Ergonomics Workplace Analysis	NPTEL
2	22AUD27	Image Signal Processing	NPTEL
3	22AUD27	Introductory Neuroscience & Neuro-Instrumentation	NPTEL
4	22AUD27	Fabrication Techniques for MEMs-based sensors	NPTEL
5	22AUD27	Nanotechnology, Science and Applications	NPTEL
6	22AUD27	Introduction to Machine Learning	NPTEL
7	22AUD27	Medical Image Analysis	NPTEL
8	22AUD27	Artificial Intelligence : Search Methods For Problem solving	NPTEL

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):

Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

M.TECH IN BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION(LBI)

Semester- 3

Bio – MEMS and Nanotechnology			
Course Code	**22LBI31**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory+10 Hours SDA	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To understand the MEMS and its uses
- To understand the materials for MEMS
- To describe the micro total analysis system

Module-1

Over view of MEMS& Microsystems and Working Principles of Microsystems: MEMS and Microsystems, Typical MEMS and Micro system Products, Evolution of Micro fabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Micro system Design and Manufacture, Applications of Microsystems in Automotive, Health Care, Aerospace and other Industries.
Working Principle of Microsystems: Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal and Biomedical& Biosensors.
Micro actuation: Using Thermal forces, Shape Memory alloys, Piezoelectric Crystals and Electrostatic forces.
MEMS with Micro actuators: Micro grippers, Micro motors, Micro valves and Micro pumps.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-2

Thermo-fluid Engineering and Microsystem Design, Scaling Laws in Miniaturization: Introduction to Thermofluidic 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 Continuum 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, Heat conduction in Multi-layered 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-3

Materials for MEMS and Microsystems, Microsystems Fabrication Processes: Substrates and Wafers, Active Substrate Materials, Silicon as a Substrate Material, Silicon Compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals, Polymers and Packaging Materials. Introduction to Micro system 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 Photo resistors, Electroplating and SLIGA Process.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-4

Introduction to BioMEMS Microactuators and Drug Delivery: What is 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, Haematology, Immunology, Microbiology, Urinalysis, Coagulation Assays, Arterial Blood gases.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

https://www.mooc.org/ https://onlinecourses.nptel.ac.in/
Skill Development Activities Suggested • To visit the nanotechnology labs for understanding the equipments

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the working principle of Microsystems	L1 L2
CO2	Able to understand the momentum equation	L2
CO3	Able to understand and analyze the materials used in Bio – MEMS	L2 L4
CO4	Able to understand the micro total analysis systems	L1 L2

Bio – Metrics and Applications			
Course Code	**22LBI321**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the biometrics as authentification
- To describe the fingerprint , face, iris, vascular pattern, gait and hand geometry recognition

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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 palm print recognition in forensics.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-3

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-5

Gait and Hand Geometry Recognition: 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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).

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To do mini project on any recognition systems

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the biometrics as authentication	L2
CO2	Able to understand and implement the finger print , face , iris recognition algorithms	L2 L3
CO3	Able to create the gait and hand geometry recognition algorithms	L6
CO4	Able to understand and analyze PCA and LDA	L2 L4
CO5	Able to analyze the feature extraction of the various recognition systems	L3

IOT for Health Care			
Course Code	**22LBI322**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explain the internet of things
- To describe IOT in various fields

Module-1	
IoT Landscape: Introduction to IoT ,Applications , Architectures , Wireless Networks ,Security and Privacy , Event-Driven Systems IoT System Architectures Basic building blocks of IoT architecture, Introduction Protocols Concepts , IoT-Oriented Protocols Databases Time Bases Security IoT Smart X Applications- Smart health platform, Smart energy, Smart home, Smart food, water, tracking and sensitivity	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-2	
IoT and Assistive Technologies for people with disabilities: IoT - integrated state-of-the-art assistive technology, IoT applications for people who are deaf/hearing impaired, blind/visually impaired, and mobility disability. Smart Sensors, Self-Powered sensors, Nano-technology sensors, Issues of the IoT-based assistive technology for people with disabilities	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-3	
IoT for ambient assisted living: Introduction, system design, general architecture, wearable devices, experimental evaluation, functional list, operation list, and results. Hybrid integration system for wearable sensor system-Introduction, State-of-the-art of current health care wearable system(WHCS), a desirable WHCS, customized IC for wearable sensors, State-of-the-Art SoC technology, Bio sensing SoC architecture and applications	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-4	
Hybrid integration system for wearable sensor system: Printed electrodes and their characteristics, electrode technology, active electrode, passive electrode, dry electrode. Hybrid integration of flexible wearable sensors: flexible circuits and interconnection, silicon on flex bio-patch implementation and miniaturization	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-5	
Role of time in IoT: Introduction, Blood flow analysis, circulation diagnosis, flow quantification, synchronization in space, blood pressure, health things-single device, distinct times, multiple device-single time, redundant device, tolerance, data reliability. Case studies: Fall detection, Physical monitoring of aged people, hygienic hand control, Chronic disease management, sports men care, remote control appliances, sleep control, animal/ human tracking, indoor climate control, waste management, etc	
Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Internet of Things from research and Innovations to market development, Ovidiu Vermsan, Peter Friess, River publishers, ISBN: 978-87-93102-94-1, 2014.
2. IoT and advanced applications in health care, Catarina Reiss, Marisa da silva maximiano, IGI Global medical information science reference, ISBN: 2237-9354.,2017.
3. Internet-of-Things (IoT)Systems Architectures, Algorithms, Methodologies, Dimitrios Serpanos, Marilyn Wolf ,ISBN 978-3-319-69714-7 © Springer Int ernational Publishing AG 2018.
4. The Industry 4.0- The Industrial Internet of Thing, Alasdair Gilchrit, ISBN 978-1-4842-2046-7

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Perform an experiments on setting up the IOT technologies

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to remember and understand IOT architecture	L1 L2
CO2	Able to understand and analyze the smart sensors used in IOT	L2 L4
CO3	Able to analyze the applications of IOT in Medical field	L4

Biomechanics & Rehabilitation Engineering			
Course Code	**22LBI323**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the biomechanics
- To understand rehabilitation engineering
- To understand prosthetic devices

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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 Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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, Callipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints-its functions & types.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books Textbooks :

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. "Rehabilitation Medicine" - By Dr. S. Sunder, 2nd Edition, Jaypee Medical Publications, Reprint 2004.
4. " Physical Rehabilitation" - by Susan B O'Sullivan, Thomas J Schmitz. 5 th Edition, Jaypee Pub.,2007.
5. "Biomechanics, Structures and Systems", A. A. Biewener, Sports Publication.
6. "Biomechanics of Human Motion", T. McClurg, Anderso n.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit multi speciality hospital for gathering more information

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the joint structure and function using Biomechanics	L2
CO2	Able to understand and analyze orthotic devices in rehabilitation engineering	L2 L4
CO3	Able to understand the kinematics analysis using Bio mechanics	L2
CO4	Able to understand and analyze the prosthetic devices	L2 L4

Wavelet Transforms and Applications			
Course Code	**22LBI324**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the continuous wavelet transform and admissibility conditions
- To describe the discrete wavelet transforms and its applications
- To understand the beyond wavelet transforms and its analysis

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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 signalling 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks:

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.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To do mini project (group wise) on signal modelling systems

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Classify various wavelet transform and explain importance of it.	L2L4
CO2	Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).	L2 L3
CO3	Explain the properties and application of wavelet transform.	L2 L4
CO4	Develop and realize computationally efficient wavelet-based algorithms for signal and imageprocessing.	L1 L2
CO5	Explain brief features and strength of transform beyond wavelet.	

Artificial Intelligence & Machine Learning			
Course Code	**22LBI325**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To describe artificial intelligence & machine learning
- To analyze the support vector machine algorithms

Module-1

Introduction: Introduction to Agents and environment; Rationality; the nature of environment; the structure of agents. Problem solving: Problem-solving agents; Example problems; Searching for solution; uninformed search strategies. Informed Search and Exploration: Informed search strategies;Heuristic functions; Constraint Satisfaction: Backtracking search for CSPs

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-2

Knowledge and Reasoning: Logical Agents: Knowledge-based agents; The Wumpus world as an example world; Logic; propositional logic: A very Simple Logic: Reasoning patterns in propositional logic; Effective propositional inference; Agents based on propositional logic. First-Order Logic, Inference in First-Order Logic – 1 : Representation revisited; Syntax and semantics of first-order logic; Using first-order logic; Knowledge engineering in first-order logic

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-3

Inference in First-Order Logic – 2: Propositional versus first-order inference; Unification and lifting forward chaining; backward chaining; Resolution.
Knowledge Representation: Ontological engineering; Categories and objects; Actions, situations, and events; Mental events and mental objects; The Internet shopping world; Reasoning systems for categories; Reasoning with default information; Truth maintenance systems

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-4

Uncertainty Measure: Probability Theory, Bayesian Belief Networks,
Machine Learning Paradigms: Machine learning system, supervised and unsupervised learnings, Inductive, deductive learning, Clustering

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-5

Support vector Machine, case-based reasoning and learning. ANN: Single Layer, Multilayer. RBF, Design issues in ANN, Recurrent Network

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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Semester End Examination:

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4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Artificial Intelligence A Modern Approach: Stuart Russel and Peter Norvig, 2nd Edition, Pearson Education, 2003.
2. Artificial Intelligence: Saroj Kaushik Cengage Learning2014 Edition
3. Artificial Intelligence: Structuresand Strategies for Complex Problem Solving George F Luger Pearso AddisonWesley 6th Ed, 2008
4. Artificial Intelligence: Elaine Rich, Kevin Knight, 3rd Edition, Tata McGraw Hill, 2009.
5. Principles of Artificial Intelligence: Nils J. Nilsson, Elsevier, 1980.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Experiments to be performed on artificial intelligence and machine learning using Matlab software

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Able to understand the agents and environment in artificial intelligence	L2
CO2	Able to understand and analyze the knowledge and reasoning in artificial intelligence	L2 L4
CO3	Able to analyze the machine learning paradigms	L4
CO4	Able to understand and analyze support vector machine for classifications	L2 L4

Data warehousing and Data Mining			
Course Code	**22LBI331**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To introduce the basic concepts of Data Warehouse and Data Mining techniques.
- Examine the types of the data to be mined and apply preprocessing methods on raw data.
- 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-4

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning	Chalk and Talk / Power Point Presentations

Process	

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
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to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- Experiments to be performed to acquire the various data mining

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Process raw data to make it suitable for various data mining algorithms.	L1 L2
CO2	Discover and measure interesting patterns from different kinds of databases.	L2 L4
CO3	Apply the techniques of clustering, classification, association finding, feature selection and visualization to real world data.	L2
CO4	Able to understand and analyze the multi media mining	L2 L4

Virtual Bio - Instrumentation			
Course Code	**22LBI332**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- It provides new concepts towards biomedical measurement and instrumentation.
- 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit multi speciality hospital to gather more information on virtual instrumenation

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Apply virtual instrumentation concept for data acquisition of biomedical signals.	L1 L2
CO2	Identify salient features of virtual bio-instrumentation tool to conduct lab experiments and possible incorporation of these traits in the projects.	L3 L4
CO3	Develop LabView based simple programs to build virtual bio-instrumentation tools for biomedical signal analysis.	L2 L4

Medical Devices Regulations, IPR and Medical Ethics			
Course Code	**22LBI333**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the practical knowledge about medical regulations, standards and intellectual property, and their relationship to quality health care and associated biomedical technology.
- 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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.
4. World Intellectual Property Organizations (WIPO) Handbook/ Notes
5. Medical device regulations: global overview and guiding principles Michael Cheng, World Health Organization
6. Product Safety in the European Union Gábor Czitán, Attila Gutassy, Ralf Wilde, TÜV Rheinl and Akadémia, 2008
7. 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.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit the patent office

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate understanding on how to the meet standards and regulatory requirements	L2
CO2	Demonstrate understanding of the practical knowledge about intellectual property, such as patent, and understand the need and practice of medical ethics.	L3 L4
CO3	Able to understand and analyze the applications of IPR	L2 L4

Cloud Computing			
Course Code	**22LBI334**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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 .

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-5

Security in the Cloud: Security Overview – Cloud Security Challenges and Risks – Softwareas-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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To implement the cloud computing for any applications

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Compare the strengths and limitations of cloud computing	L1 L2
CO2	Apply suitable virtualization concept.	L1 L2 L3
CO3	Choose the appropriate cloud player and appropriate Programming Models and approach.	L4
CO4	Address the core issues of cloud computing such as security, privacy and interoperability Design Cloud Services	L2 L4

BioSensors			
Course Code	**22LBI335**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Comprehend the fundamental theory of biosensors.
- Analyze the working mechanisms of the most common types of biosensors.
- Apply knowledge to design a specific transduction mechanism.
- 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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Module-2

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

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

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.

Teaching-Learning Process	Chalk and Talk / Power Point Presentations

Assessment Details (both CIE and SEE)

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Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
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5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Milton Keynes "Biosensors" Elizabeth A. H Hall - Open University press,.ISBN-10: 0471932264.cf
2. Graham Ramsay "Commercial Biosensors", John Wiley and son, INC. 1998.ISBN 978-0471-58505-3.
3. Dr.S.Shanmugam, I. K. "Enzyme Technology" International Pvt Ltd,2009. ISBN9380026056, 9789380026053
4. "Biosensors edited by AEG CASS" – OIRL press, Oxford University.
5. Murthy D V S. "Transducers and Instrumentation", Prentice Hall, 1995.

Web links and Video Lectures (e-Resources):

https://www.mooc.org/
https://onlinecourses.nptel.ac.in/

Skill Development Activities Suggested

- To visit multi speciality hospital for gathering more information on Biosensors
- To do experiments on various Biosensors to acquire bio medical signals.

Course Outcomes

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

Sl. No.	Description	Blooms Level
CO1	Explain the various sensors and transducers available for physiological and cellular measurements and their applications.	L1 L2 L4
CO2	Apply the operations of various sensors in a bio signal processing systems.	L1L2
CO3	Analyze electrical/mechanical engineering concepts for a range of problems and medical applications.	L3
CO4	Design and synthesize the transducer usage for various biosensor applications.	L1 L2

PROJECT WORK PHASE - 1			
Course Code	**22LBI34**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organization, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instill responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted. Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25. **RBT Level: L3, L4, L5, L6**

SOCIETAL PROJECT			
Course Code	**22LBI35**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organization, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instill responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake societal problem identification, formulation and solution.
3. Design engineering solutions to complex societal problems utilising a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25**.

NOTE: Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

RBT Level: L3, L4, L5, L6

INTERNSHIP			
Course Code	**22LBII36**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	06 weeks Internship Completed during the intervening vacation ofII and III semesters.	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	06	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objectives are further,
- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, publicspeaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently

Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree.

Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal careergoals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

- Acquire the knowledge of administration, marketing, finance and economics

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session inthe ratio of **50:25:25**.

Semester End Examination

SEE marks for the Internship Report (30 Marks), Seminar (15 Marks) and Question and Answer Session (15 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

NOTE: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

RBT Level: L3, L4, L5, L6

M.TECH IN BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION(LBI)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year 2022-23)

SEMESTER –IV

PROJECT WORK PHASE - 2			
Course Code	**22LBI41**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:8:0)	SEE Marks	100
Total Hours of Pedagogy	40 hours Practical	Total Marks	200
Credits	18	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging thesources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audienceconfidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-2: Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1 to complete the Project work. Each student / batch of students shall prepare project report as per the norms avoiding plagiarism and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas andinformation so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills

- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.

Work in a team to achieve common goal.

- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25.**

Semester End Examination

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. SEE marks for the project report (50 marks), seminar (25 marks) and question and answer session (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed

by the University. **RBT Level: L3, L4, L5, L6**