VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus
M.Tech. **BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION** (LBI)
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2020-21
M.Tech.: BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION (LBI)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours / Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20LBI11	Mathematics for Biomedical Engineering	03	--	02	03	40	60	100	4
2	PCC	20LBI12	Physiology for Biomedical Engineering	03	--	02	03	40	60	100	4
3	PCC	20LBI13	Modern Medical Instrumentation	03	--	02	03	40	60	100	4
4	PCC	20LBI14	Advanced Biomedical Signal Processing	03	--	02	03	40	60	100	4
5	PCC	20LBI15	Medical Imaging Techniques and Systems	03	--	02	03	40	60	100	4
6	PCC	20LBIL16	Biomedical Signal Processing and Instrumentation Laboratory	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**16**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional Core Course

Skill Development Activities (SDA):
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/testing/projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in the case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical / Seminar	Skill Development Activities	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20LBI21	Advanced Medical Image Processing	03	--	02	03	40	60	100	4
2	PCC	20LBI22	Speech Signal Processing	03	--	02	03	40	60	100	4
3	PCC	20LBI23	Neural Network and Fuzzy Logic in Medicine	03	--	02	03	40	60	100	4
4	PEC	20LBI24X	Professional Elective-1	04	--	--	03	40	60	100	4
5	PEC	20LBI25X	Professional Elective-2	04	--	--	03	40	60	100	4
6	PCC	20LBIL26	Speech and Image Processing Laboratory	--	04	--	03	40	60	100	2
7	PCC	20LBI27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional Core Course, PEC: Professional Elective Course

Professional Elective-1		**Professional Elective-2**	
Course Code	**Course Title**	**Course Code**	**Course Title**
20LBI241	Photonics for Medical Imaging	20LBI251	Biomaterials and Artificial Organs
20LBI242	Bioinformatics and Applications	20LBI252	Wireless Technologies for Medical Applications
20LBI243	Health Care Data Analytics	20LBI253	ARM Embedded System Design
20LBI244	Statistical Signal Processing	20LBI254	Artificial Intelligence

Note:
1. Technical Seminar: 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. Participation in the seminar by all postgraduate students of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or 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. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical / Mini-project / Internship	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20LBI31	Bio-MEMS and Nanotechnology	03	--	02	03	40	60	100	4
2	PEC	20LBI32X	Professional Elective-3	03	--	--	03	40	60	100	3
3	PEC	20LBI33X	Professional Elective-4	03	--	--	03	40	60	100	3
4	Project	20LBI34	Project Work Phase -1	--	02	--	--	100	--	100	2
5	PCC	20LBI35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20LBII36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional Core Course, PEC: Professional Elective Course.

Professional Elective-3		Professional Elective-4	
Course Code	**Course Title**	**Course Code**	**Course Title**
20LBI321	Biometrics and Applications	20LBI331	Biostatistics
20LBI322	Wavelet Transforms and Applications	20LBI332	Virtual Reality
20LBI323	Biomechanics and Rehabilitation Engineering	20LBI333	IoT for Healthcare
20LBI324	Machine Learning	20LBI334	Modelling and Simulation in Biomedical Engineering

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

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 Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in 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.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination: 2020-19
M.Tech.: BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION (LBI)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	20LBI41	Project Work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

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

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

1st Semester Syllabus

Mathematics for Biomedical Engineering			
Course Code	20LBI11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Vector Spaces: Vector spaces and subspaces; Linearly independent sets; bases, coordinate systems, dimension of a vector space; Rank, Change of basis Applications to difference equations.
(Text Book:1)(RBT Levels: L1 & L2).

Module-2

Linear Transformations: Linear transformations; eigen vectors and eigen values, characteristic equation, diagonalization, eigen vectors and linear transformation, Complex eigen values, Applications to differential equations
(Text Book:1) (RBT Levels: L2 & L3)

Module-3

Orthogonality and Least Squares: Inner products, length and orthogonality, orthogonal sets, orthogonal projections; Gram-Schmidt process; QR-factorization; least-squares problems; Inner products spaces, Application to linear models, Application of inner product spaces.
(Text Book:1) (RBT Levels: L2 & L3)

Module-4

Symmetric Matrices and Quadratic Forms: Digitalization of symmetric matrices; quadratic forms; constrained optimization; singular value decomposition, Application to image processing and statistics
(Text Book:1) (RBT Levels: L2 & L3)

Module-5

Probability Theory :- Random variable: Discrete and continuous, Probability distributions, probability mass function and density function, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions-examples.
(Text Book: 2 & Ref.Book:4) (RBT Levels: L1 & L2)

Course Outcomes: 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.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question consisting of 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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, 2nd Edition,2013.
3. Gilbert Strang: Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press., 2016

Reference books:

1. T.Veerarajan "Probability, Statistics and Random Process", 3rd Edition, Tata Mc-Graw Hill Co.,2016.

Physiology for Biomedical Engineering			
Course Code	20LBI12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

General Physiology: Cell, Cell junctions, Transport through cell membrane, Homeostasis, Acid base balance.
Respiratory System & Environmental Physiology: Physiological anatomy of respiratory tract, Pulmonary circulation, Mechanics of respiration, Pulmonary function tests, Ventilation, Exchange of respiratory gases, Transport of respiratory gases, Regulation of respiration, Artificial respiration.

Module-2

Renal Physiology : Kidney, Nephron, Juxtaglomerular apparatus, Renal circulation, Urine formation, Concentration of urine, Acidification of urine, Renal function tests, Renal disorders, Micturition, Uro flow studies, Dialysis.
Cardiovascular System : Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle, Heart sounds, Cardiac murmurs, Electrocardiogram, Vector, Arrhythmia, Cardiac output, Regulation of heart rate, Hemodynamics, Arterial blood pressure, Haemorrhage.

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.

Module-4

Physiology of sleep, Epilepsy, cerebrospinal fluid, Autonomic nervous system and ANS tests. Evoked potentials. Cerebral circulation and tests.
Muscle Physiology: Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction, Electromyogram & disorders of skeletal muscles.

Module-5

Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.
Physiology of Eye and Ear: Structure of the Eye, Visual process, Field of vision, Visual pathway, Pupillary reflexes, Colour vision, Errors of refraction. ERG and EOG. Structure of ear, Auditory defects.

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

1. Describe human physiology at a cellular, tissue, and organ systems level.
2. Discuss the integration and control of the different physiological systems and their roles in maintaining homeostasis.
3. Develop basic knowledge in working of major body systems and the physiological parameters associated with them.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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.

Modern Medical Instrumentation			
Course Code	20LBI13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Module-2

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

Module-3

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

Module-4

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

Module-5

Respiratory & Advanced Diagnostic & Therapeutic Instruments: Pulmonary function measurement, basic spirometer, ultrasonic spirometer, Pneumotachometer, Measurement of volume by Nitrogen washout technique. Artificial kidney-Principle and haemodialysis machine. 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.

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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.

Reference Books:

1. Leslie Cromwell & others, Biomedical Instrumentation and Measurements, Wiley Publications, 2nd Edition, 2010.
2. Richard Aston, Principles of Biomedical Instrumentation and Measurement, Prentice Hall of India, 4th Edition, 2005.

Advanced Biomedical Signal Processing			
Course Code	20LBI14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: General measurement and diagnostic system, classification of signals, introduction to biomedical signals, Biomedical signal acquisition and processing, Difficulties in signal acquisition.
ECG: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis, Arrhythmia, Arrhythmia analysis, Arrhythmia monitoring system.

Module-2

ECG Data Reduction: Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loeve Transform, Other data compression Techniques: DPCM, Huffman coding, Data compression Techniques comparison.
Signal Averaging: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging.

Module-3

Frequency Domain Analysis: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG,
Time Series Analysis: Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models. Spectral modelling and analysis of PCG signals.

Module-4

Spectral Estimation: Introduction, Blackman- tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD techniques. Comparison of the PSD estimation methods.
Event Detection and waveform analysis: Need for event detection, Detection of events & waves, Correlation analysis of EEG signals, The matched filter, Detection of the P wave , Identification of heart sounds, Morphological analysis of ECG waves, analysis of activity.

Module-5

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

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

1. Implement the various types of processing techniques carried out on biomedical signals which meet the current Industry needs.
2. Develop an interest to design new modelled algorithm more and more continually.
3. Develop an interest to simulate the models and validate its functionality in real time systems.
4. Demonstrate an ability to integrate different concepts to develop new models that suits current trends of Industries and analyze its performance.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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

Medical Imaging Techniques and Systems			
Course Code	20LBI15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Module-2

Computed Tomography : Conventional tomography, Computed tomography principle, Generations of CT machines – First, Second, Third, Fourth, Fifth, Sixth & Seventh, Projection function,
Reconstruction algorithms – Back Projection Method, 2D Fourier Transform Method, Filtered Back Projection Method, Iteration Method, Parallel Beam Reconstruction, Fan Beam Reconstruction, Helical CT Reconstruction.

Module-3

Ultrasound 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.

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 – pyroelectric vidicon camera clinical thermography – liquid crystal thermography.

Module-5

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Reference Books:

1. Medical Imaging Signals and Systems, Jerry L Prince & Jonathan M Links, Pearson Prentice Hall.
2. The physics of medical imaging, Steve Webb, Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
3. Basics of MRI, Ray H Hashemi & William G Bradley Jr, Lippincott Williams & Wilkins.
4. Diagnostic Ultrasound Principles & Instruments, 5th Edition, Frederick W Kremkau.
5. 2D Echocardiography, Jay N Schapira, Williams & Wilkins

Biomedical Signal Processing and Instrumentation Lab			
Course Code	20LBIL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Laboratory Experiments:

Hardware

1. Acquisition and Analysis of ECG, EMG and EEG.
2. Testing hearing ability and air conduction thresholds using audiometer and plotting of audiogram.
3. Conduct experiments to measure (i) Blood Pressure using sphygmomanometer and automated system, and (ii) Heart rate and Heart sounds using Phonocardiograph.
4. Design and implementation of circuits with biomedical applications (like QRS detector, ECG Amplifier, EMG amplifier, Instrumentation amplifier)
5. Study and acquisition of PPG and Realization of a Pacemaker circuit.

Software: Matlab based:

6. Develop Matlab programs to perform convolution, correlation and FFT.
7. Develop Matlab programs to implement FIR filters and IIR filters
8. Spectral Modelling and Analysis of ECG Signals
9. Detection of QRS complex and heart rate measurement.
10. Auto-correlation and cross correlation of ECG signals.
11. Signal Averaging to improve the SNR.
12. Design of 50 Hz notch filter for ECG signal and display PSD.
13. Data Compression Techniques: AZTEC, TP, FAN algorithms.
14. Design of Wiener Filter to remove Artifacts in ECG Signal.
15. Design of Adaptive Noise Canceller for the removal of Interference and Noise in Bio signals.

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

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

Research Methodology and IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 5 Hrs

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. 5Hrs

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. 5Hrs

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. 5Hrs

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. 5Hrs

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

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
Question Paper Pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.
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.
Reference Books: 1. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005. 2. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF 1st SEMESTER SYLLABUS***

2nd Semester Syllabus

Advanced Medical Image Processing			
Course Code	20LBI21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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.

Module-2

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

Module-3

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

Module-4

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

Module-5

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Reference Books:

1. Image Processing, Analysis and Machine Vision, Milan Sonka, Vaclav Hlavac & Roger Boyle, 2nd Edition.
2. Digital Image Processing, Rafael C. Gonzalez & Richard E. Woods, First Edition. Pearson Education Inc.
3. Practical Algorithms for Image Analysis: Description, Examples & Codes by Michael Seul, Lawrence O'Gorman, Michel J.Sammon, Cambridge University Press.
4. Biomedical Imaging visualization and analysis, Richard A Robb, John Wiley & Sons, Inc.

Speech Signal Processing			
Course Code	20LBI22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

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

Module-2

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

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

Module-3

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

Module-4

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

Module-5

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

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Reference Books:

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

Neural Network and Fuzzy Logic in Medicine			
Course Code	20LBI23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Learning and Soft Computing: Examples, basic tools of soft computing, basic mathematics of soft computing, Differences between neural network and Biological neural network, Network Architecture, Artificial Intelligent
Learning process : Error correction Algorithm, Memory based Learning, Hebian Learning, Learning with Teacher, Learning without Teacher

Module-2

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

Module-3

Multilayer Perception: Error back propagation algorithm, generalized delta rule, XOR Problem, Practical Aspects of Error Back Propagation Algorithm. Problems
Radial Basis Function Networks: Ill Posed Problems and Regularization Technique, Stabilizers and Basis Functions, Generalized Radial Basis Function Networks.

Module-4

Support Vector Machines : Risk minimization principles and the Concept of Uniform Convergence, VC dimension, Structural Risk Minimization, support vector machine algorithms
Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Operations on Fuzzy Sets, Fuzzy Arithmetic, Compliment, Intersections, Unions, Fuzzy Relation.

Module-5

Fuzzy Rule based system Linguistic Hedges. Rule based system, Graphical techniques for Inference, Fuzzification and 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. Introduction to Neuro-fuzzy logic tool using LabView

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. S. Haykin, "Neural networks: A Comprehensive Foundation"' 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

Reference Books:

1. Vojislav Kecman, "Learning and soft computing", Pearson Education (Asia) Pvt. Ltd.2004.
2. M.T.Hagan, H.B.Demuth and M. Beale, "Neural Network Design", Thomson Learning, 2002.
3. George J. Klir and Bo Yaun, "Fuzzy sets and Fuzzy Logic: Theory and Application", Prentice Hall of India, 2001.

Photonics for Medical Imaging			
Course Code	20LBI241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

Module-2

Bio-imaging: Principles and Techniques: An Overview of Optical Imaging, Transmission Microscopy, Simple Microscope, Compound Microscope, Kohler Illumination, Numerical Aperture and Resolution.

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.

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

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.

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

1. Analyze the laser principles with safety regulations, optical set up design for biomedical applications.
2. Utilize optical components for microscopes in biomedical imaging with simulation research studies with a research analysis report.
3. Understand the optical biosensor for image transduction and case study analysis.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

1. Introduction to Bio-photonics, Paras N Prasad, A John Wiley & Sons, Inc., Publication. 2003.

Reference Book:

1. Fundamentals of Light Microscopy & Electronic Imaging, Douglas B Murphy, John Wiley & Sons, 2001.
2. Biomedical Optics: Principles and Imaging, Lihong V Wang, Hsin-I Wu, May 2007.

Bioinformatics and Applications			
Course Code	20LBI242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

The Central Dogma: Watson's definition, information flow, from data to knowledge, Convergence, the organization of DNA, the organization of Proteins. XML (Bio XML) for Bioinformatics: Introduction, Differences between HTML and XML, fundamentals of XML, fundamentals of XML namespaces. Introduction to DTDs, Document type Declarations, Declaring elements, declaring attributes, working with entities XML Schemas, Essential Concepts, working with simple types, working with complex types, Basic namespaces issues.

Module-2

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

Module-3

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

Module-4

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

Module-5

Phylogenetic Analysis: Introduction, methods of Phylogenetic analysis, distance methods, the neighbour-Joining (NJ) method, The Fitch/ Margoliash method, character-based methods, Other methods, Tree evaluation and problems in phylogenetic analysis.
Clustering**:** Protein structure visualization and Protein structure prediction.

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

1. Explain the relationship of molecular biology and bioinformatics to computer science.
2. Discuss the basics of XML programming briefs about the DTDs and the XML Schemas.
3. Develop technique to concatenate two DNA fragments
4. Apply the knowledge in creation of the database.
5. Discuss about the biological motivation of sequence analysis.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. Bioinformatics Methods and Applications, S.C.Rastogi, N. Mendiratta.
2. XML for Bioinformatics, CERAMI.
3. Beginning Perl for Bioinformatics, James D. Tisdall.
4. Bioinformatics Computing, Bryan Bergeron, M.D

Health Care Data Analytics			
Course Code	20LBI243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Introduction to big data, risks of big data, structure of big data, exploring big data, filtering big data effectively, mixing big data with traditional data, need for standards-today's big data is not tomorrow's big data, web data: the original big data, web data overview web data in action, cross-section of big data sources and the value they hold.

Data Analysis: Evolution of analytic scalability, convergence, parallel processing systems, cloud computing, grid computing, map reduce, enterprise analytic sand box, analytic data sets analytic methods, analytic tools, cognos, micro strategy, pentaho, analysis approaches, statistical significance, business approaches, analytic innovation, traditional approaches.

Module-2

Mining Data Streams: Introduction to streams concepts, stream data model and architecture, stream computing, sampling data in a stream, filtering streams, counting distinct elements in a stream, estimating moments, counting oneness in a window, decaying window, real time analytics platform (RTAP) applications, case studies, real time sentiment analysis, stock market predictions.

Module-3

Frequent itemsets and Clustering: Mining frequent itemsets ,market based model ,apriori algorithm, handling large data sets in main memory, limited pass algorithm, counting frequent itemsets in a stream ,clustering techniques ,hierarchical ,k-means ,clustering high dimensional data ,clique and proclus , frequent pattern based clustering methods , clustering in non-Euclidean space ,clustering for streams and parallelism.

Module-4

Frameworks and Visualization: Mapreduce , Hadoop, Hive, Mapr, Sharding , Nosql databases Hadoop distributed file systems, Visualizations -visual data analysis techniques, interaction techniques; systems and applications.

Module-5

Applications: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health-Fraud Detection in Healthcare-Data Analytics for Pharmaceutical Discoveries-Clinical Decision Support Systems-Computer-Assisted Medical Image Analysis Systems-Mobile Imaging and Analytics for Biomedical Data.

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

1. Recall about Big Data, Data Analysis, Data Streams, Clustering & frameworks.
2. Explain Analytical Scalability, Stream computing and its applications.
3. Make use of different Frame works and Visualization techniques.
4. Analyze different clustering techniques.
5. Develop cases involving big data analytics in solving practical problems.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Stream with advanced analytics, Bill Franks, John Wiley & sons, 2012.
2. Mining of Massive Datasets, Anand Rajaraman and Jefrey David Ulman, Cambridge University Press, 2012.
3. Healthcare data analytics, Chandan K. Reddy and Charu C Aggarwal, Taylor & Francis, 2015
4. Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Hui Yang and Eva K. Lee, Wiley, 2016.

Reference Books:

1. Core Java, Horstmann, Cay S, 10th Edition, Prentice Hall, 2016, ISBN: 9780134177304.
2. Java The Complete Reference, Herbert Schildt,8th Edition, Tata McGraw Hill, 2011.
3. Java 9 Recipes - A Problem-Solution Approach, Josh Juneau, 3rd Edition, Apress, 2017.
4. Introduction to JAVA Programming, Y. Daniel Liang, 6th Edition, Pearson Education, 2007.

Statistical Signal Processing			
Course Code	20LBI244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

Module-2

Spectral Estimation and Analysis -Non parametric methods: Periodogram, Bartlett and Welch modified periodogram, Blackman-Tukey Methods.

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.

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. 12 Hrs

Module-5

Adaptive Algorithms to adjust coefficients of digital filters: Least Mean Square (LMS), Recursive Least Square (RLS) and Kalman Filter Algorithms. 10 Hrs

Course Outcomes: Students will be able to

1. Develop Signal modelling using Least Square Methods.
2. Explain spectral estimation and analysis of signals using Non parametric methods.
3. Determine spectral estimation and analysis of signals using parametric methods.
4. Apply basic concepts of forward and backward Linear prediction
5. Explain principles of LMS and RLS adaptive algorithms and Kalman filters

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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

Reference Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications, Proakis, John G., Dimitris G. Manolakis, and D. Sharma:, Pearson Education, 2006.
2. Digital Signal Processing a computer Based approach, Mitra Sanjit.K, Tata McGraw Hill, 2001.
3. Adaptive Signal Processing, B. Widrow & S Stearns, PHI, 1985.
4. Statistical and Adaptive Signal Processing, Dimitris, Manolakis, McGraw Hill, 2000.

Biomaterials and Artificial Organs			
Course Code	20LBI251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Structure of Bio-Materials and Bio-Compatibility

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

Module-2

Implant Materials

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

Module-3

Polymeric Implant Materials

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

Module-4

Tissue Replacement Implants

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

Module-5

Artificial Organs

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Reference Books:

1. Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 1984.
2. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003.
3. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005.

Wireless Technologies for Medical Applications			
Course Code	20LBI252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

Module-2

Wireless Body Area Network (WBAN): Network Architecture, Network Components, Design Issues, Network Protocols, WBAN Technologies, WBAN Applications.

Module-3

Wireless Personal Area Networks: Wireless Personal Area Network (WPAN) , Network Architecture, WPAN Components, WPAN Technologies and Protocols, WPAN Applications.

Module-4

Wireless Local Area Networks: Network Components, Design Requirements of WLAN, Network Architecture, WLAN Standards, Case studies in biomedical domain.

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.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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

1. Understand the fundamentals of wireless technologies involved in health domain application.
2. Apply advanced wireless technologies for biomedical applications.
3. Analyze sensor network techniques for the hospital management.
4. Evaluate the impact of the technology on society, and relate this to global issues, governmental issues and economics.

Reference 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.

ARM Embedded System Design			
Course Code	20LBI253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction To Embedded systems

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

Module-2

ARM Embedded Systems and ARM processor fundamentals

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

Module-3

Introduction to ARM instruction set and

Data processing instructions, branch instructions, load-store instructions, software interrupts instruction, Program status register instructions, loading constants, ARMv5E extensions, conditional execution.

Module-4

Introduction to the thumb instruction set and Exception and interrupt handling

Thumb register usage, ARM-Thumb interworking, data processing instructions, Single & multiple-register Load-store instruction, stack instructions, software interrupt instruction, Exception handling, interrupts, interrupt handling schemes.

Module-5

Embedded operating systems and Future of the Architecture

Fundamental components, **Example:** Simple little operating system. Advanced DSP and SIMD support in ARMv6, System and multiprocessor support additions to ARMv6, Armv6 implementations, Future technologies beyond ARMv6.

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Reference Book:

1. ARM System on chip Architecture Addison Wesley, Formatted: paperback, 2008, ISBN:978-0201675191.

Artificial Intelligence			
Course Code	20LBI254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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

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

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

Module-4

Planning: The problem; Planning with state-space approach; planning graphs; Planning with propositional logic. Uncertainty: Acting under certainty; Inference using full joint distributions; Independence; Bayes' rule and its use.

Probabilistic Reasoning: Representing knowledge in an uncertain domain; the semantics of Bayesian networks; efficient representation of conditional distributions; exact inference in Bayesian networks

Module-5

Learning: Learning from Observations: Forms of Learning; Inductive learning; Learning decision trees; Ensemble learning; Computational learning theory.AI: Present and Future: Agent components; Agent architectures; Are we going in the right direction? What if AI does succeed?

Course Outcomes: Students will be able to,

1. Illustrate the fundamentals of knowledge representation, inference and theorem proving.
2. Analyze simple knowledge-based systems.
3. Design various AI Search algorithms
4. Apply working knowledge of reasoning in the presence of incomplete and /or uncertain information.
5. Explain knowledge representation, reasoning, and machine learning techniques to real-world problems

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

1. Artificial Intelligence A Modern Approach: Stuart Russel and Peter Norvig, 2nd Edition, Pearson Education, 2003.

Reference Books:

1. Artificial Intelligence: Elaine Rich, Kevin Knight, 3rd Edition, Tata McGraw Hill, 2009.
2. Principles of Artificial Intelligence: Nils J. Nilsson, Elsevier, 1980.

NPTEL Learning Material: http://nptel.ac.in/courses/106105077/

Speech and Image Processing Lab			
Course Code	20LBIL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

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

Speech Signal Processing:

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. Applications of Wavelets in Medical Image Processing.

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

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

TECHNICAL SEMINAR			
Course Code	20LBI27	CIE Marks	100
Number of contact Hours/week (L:P:SDA)	0:2:0	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

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

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic 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.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20LBI27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF 2nd SEMESTER SYLLABUS***

3rd Semester Syllabus

Bio-MEMS and Nanotechnology			
Course Code	20LBI31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Module-2

Thermo-fluid Engineering and Microsystem Design, Scaling Laws in Miniaturization: Introduction to 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.

Module-3

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

Module-4

Introduction to BioMEMS Microactuators and Drug Delivery: What 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.

Module-5

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

Course Outcomes: At the end of this course the **s**tudents will be able to

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. Tai Ran Hsu, “MEMS and Microsystems, Design & Manufacture” , TMH2002
2. Steven S. Saliterman, “Fundamentals of BioMEMS and Medical Microdevices”, Cengage Learning, India Edition

Reference Books:

1. Mohammed had-el-hak, “MEMS Introduction & Fundamentals” ,CRC Press.
2. Harisingh Nalwa, “Nanoscience and Nanotechnology”, American Scientific Publishers.
3. Sergey Edward Lyshevski, “Nano &MEMS”, CRC press
4. Nadim Maluf, “An Introduction to MEMS Engineering” , Artech House Publishing.
5. Taun-Vo-Dish, “Nanotechnology in Biology & Medicine methods” , devices & Applications, CRC.

Biometrics and Applications			
Course Code	20LBI321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

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

Module-2

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

Module-3

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

Module-4

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

Module-5

Gait and Hand Geometry 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.

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

1. Express the importance of biometrics, operation of biometric systems, characteristics and performance of biometrics, forensic identification
2. Design and develop finger print recognition system, acquisition devices, segmentation algorithms, matching approaches, palm print sensing and recognition
3. Explain and interpret face recognition system, acquisition devices, algorithms, and ear biometric recognition system
4. Describe iris recognition system, acquisition devices, algorithms, encoding and matching, hand vascular pattern acquisition and recognition
5. Explain and interpret gait and hand biometric system, acquisition, processing algorithms, feature extraction and matching.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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

Wavelet Transforms and Applications			
Course Code	20LBI322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

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

Module-2

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

Module-3

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

Module-4

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

Module-5

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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.

Biomechanics and Rehabilitation Engineering			
Course Code	20LBI323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

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

Module-2

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

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

Module-3

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

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

Module-4

Orthotic Devices in Rehabilitation Engineering:

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

Module-5

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

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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. 5th Edition, Jaypee Pub.,2007.

Reference Books:

1. "Biomechanics, Structures and Systems", A. A. Biewener, Sports Publication.
2. "Biomechanics of Human Motion", T. McClurg, Anderson.

Machine Learning			
Course Code	20LBI324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Learning Problems, Designing Learning systems, Perspectives and Issues. Concept learning: Concept Learning, Version Spaces and Candidate Elimination Algorithm, Inductive bias. Decision Trees: Decision Tree learning, Representation, Algorithm, Heuristic Space Search.

Module-2

Regression: Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM Clustering: k-means, Adaptive hierarchical clustering, Gaussian mixture model.

Module-3

Neural Networks: Neural Network Representation, Problems, Perceptron, Multilayer Networks and Back Propagation Algorithms. Genetic Algorithms: Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning.

Module-4

Bayesian Learning: Bayes Theorem, Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, EM Algorithm

Module-5

Instant Based Learning: K-Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Sequential Covering Algorithm. Learning set of rules: Learning Rule Sets, Learning First Order Rules, Learning Sets of First Order Rules, Induction as Inverted Deduction, Inverting Resolution.

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

1. Apply the knowledge of learning problems and models used in machine learning.
2. Identify and analyze the learning models to interpret the data.
3. Design , implement and demonstrate an open-ended experiment for biomedical data using modern tool.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (INDIAN EDITION), 2013.
2. Ethem Alpaydin, “Introduction to Machine Learning”, 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Reference Books:

1. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer; 1st edition, 2001.

Biostatistics			
Course Code	20LBI331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

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

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

Module-2

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

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

Module-3

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

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

Module-4

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

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

Module-5

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

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

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. "Biostatistics-A Foundation for Analysis in the Health Sciences" Wayne W. Daniel, John Wiley & Sons Publication, 6th Edition.
2. "Basic Biostatistics and its Applications" Animesh K. Dutta (2006)

Reference Books:

1. "Principles of Biostatistics", Marcello Pagano and Kimberlee Gauvreu, Thomson Learning Pub., 2006.
2. "Introduction to Biostatistics" by Ronald N Forthofer and Eun Sul Lee, Academic Press.

Virtual Reality			
Course Code	20LBI332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Definition of VR, modern experiences, historical perspective. Hardware, sensors, displays, software, virtual world generator, game engines, human senses, perceptual psychology, psychophysics. Geometric modelling, transforming rigid bodies, yaw, pitch, roll, axis-angle representation, quaternions, 3D rotation inverses and conversions, homogeneous transforms, transforms to displays, look-at and eye transforms, canonical view and perspective transforms, viewport transforms

Module-2

Light propagation, lenses and images, diopters, spherical aberrations, optical distortion; more lens aberrations; spectral properties; the eye as an optical system; cameras; visual displays. Parts of the human eye, photoreceptors and densities, scotopic and photopic vision, display resolution requirement, eye movements, neural vision structures, sufficient display resolution, other implications of physiology on VR. Depth perception, motion perception, vection, stroboscopic apparent motion, colour perception, combining information from multiple cues and senses, implications of perception on VR

Module-3

Graphical rendering, ray tracing, shading, BRDFs, rasterization, barycentric coordinates, VR rendering problems, anti-aliasing, distortion shading, image warping (time warp), panoramic rendering. Velocities, acceleration, vestibular system, virtual world physics, simulation, collision detection, avatar motion, vection.

Module-4

Tracking systems, estimating rotation, IMU integration, drift errors, tilt and yaw correction, estimating position, camera-feature detection model, perspective n-point problem, sensor fusion, lighthouse approach, attached bodies, eye tracking, inverse kinematics, map building, SLAM. Remapping, locomotion, manipulation, social interaction, specialized interaction mechanisms.

Module-5

Sound propagation, ear physiology, auditory perception, auditory localization; Fourier analysis; acoustic modelling, HRTFs, rendering, auralization. Perceptual training, recommendations for developers, best practices, VR sickness, experimental methods that involve human subjects Touch, haptics, taste, smell, robotic interfaces, telepresence, brain-machine interfaces

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

1. Explain fundamentals of virtual reality systems
2. Summarize the hardware and software of the VR
3. Analyse the applications of VR

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook:

Virtual Reality, Steven M. LaValle. Cambridge University Press 2016, http://vr.cs.uiuc.edu/book.html

Reference Book

Handbook of Virtual Environments: Design, Implementation, and Applications, Kelly S. Hale and Kay M. Stanney, CRC Press, 2nd Edition, 2015

IoT for Healthcare			
Course Code	20LBI333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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

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

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

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

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 (any one per student)

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

1. Explain the fundamentals required for IoT.
2. Apply the concepts of IoT to medical devices.
3. Evaluate performance of IoT against other technologies.
4. Create an IoT application for biomedical Engineering.

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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 International Publishing AG 2018.
4. The Industry 4.0- The Industrial Internet of Thing, Alasdair Gilchrit, ISBN 978-1-4842-2046-7

Modelling and Simulation in Biomedical Engineering			
Course Code	20LBI334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Modeling continuous – time signals as sums of sine waves

Introduction, analysis of circadian rhythm, orthogonal functions, sinusoidal basis functions, the Fourier series, the frequency response and non-sinusoidal periodic inputs, Parseval's relation for periodic signals, CTFT, relationship of Fourier transform to frequency response, properties of the Fourier transform, the generalized Fourier transform, examples Fourier transform calculations, Parseval's relation for nonperiodic signals, filtering, output response via the Fourier transform.

Module-2

Modeling signals as sums of discrete-time sine waves

Introduction, introductory example, the discrete-time Fourier series, Fourier transform of discrete-time signals, Parseval's relation for DT nonperiodic signals, output of an LSI system, relation of DFS and DTFT, windowing, sampling, DFT, biomedical applications.

Module-3

Modeling stochastic signals as filtered white noise

Introduction, EEG analysis, random processes, mean and auto correlation function of random process, stationarity and ergodicity, general linear processes, Yule-Walker equations, Autoregressive(AR) processes, Moving Average (MA) processes, Autoregressive - Moving Average (ARMA) processes, harmonic processes, biomedical examples.

Module-4

Nonlinear models of signals

Introduction, nonlinear signals and systems, Poincare sections and return maps, chaos, measures of nonlinear signals and systems, characteristic multipliers and Lyapunov exponents, estimating the dimension of real data, tests of null hypotheses based on surrogate data, biomedical applications.

Module-5

Modeling biomedical systems

Problem statement, illustration of the problem, point processes, parametric system modelling, autoregressive or all-pole modelling, pole-zero modelling, electromechanical models of signal generation, applications.

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

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

Question Paper Pattern:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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

PROJECT WORK PHASE – 1			
Course Code	20LBI34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- 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, 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 audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

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:

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

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20LBI35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- 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 the sources) 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 audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: 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:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information 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.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20LBI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice 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 objective is 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, public speaking, 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/Professional practice: 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 career goals.
- 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 for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 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.

*** END OF 3rd SEMESTER SYLLABUS***

4th Semester Syllabus

PROJECT WORK PHASE -2			
Course Code	20LBI41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) 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 audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - 2: 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:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information 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:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 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.