VII SEMESTER

Sub Title: BIOMEDICAL DIGITAL SIGNAL PROCESSING		
Sub Code: ML71	**No. of Credits : 3=3: 0: 0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. To learn the nature of various biomedical signals and its analysis.
2. To know about neurological signal generation.
3. To study sleep EEG types and their features.
4. To study adaptive filters and their applications in biomedical signal processing.
5. To gain knowledge about various artefacts and methods to eliminate it.
6. To study cardiological signal processing

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO BIOMEDICAL SIGNALS:** The nature of biomedical signals, the action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis. Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis. EMG signal characteristic and analysis	**7**
2	**SLEEP EEG:** Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, and Event history analysis for modeling sleep.	**6**
3	**ADAPTIVE FILTERS:** Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 60 Hz interference in electrocardiography, applications of adaptive filters. Canceling donor - heart interference in heart-transplant electrocardiography, Cancellation of ECG signal from the electrical activity of the chest muscles, canceling of maternal ECG in fetal ECG, Cancellation of High frequency noise in Electro - surgery.	**9**
4	**SIGNAL AVERAGING:** Basics of signal averaging, a typical signal averager, signal averaging as a digital filter, Removal of artifacts by averaging. Filtering for removal of artifacts**:** Introduction, Random noise, structured noise and physiological interference, stationary versus non stationary process, high frequency noise in ECG, motion artifact in ECG, power line interference in ECG signals, Maternal interference in Fetal ECG, muscle contraction interference in VAG signals.	**9**
5	**CARDIOLOGICAL SIGNAL PROCESSING:** Pre-processing. ECG QRS Detection techniques. Rhythm analysis. Arrhythmia detection Algorithms. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis, ST–segment analyzer, portable, arrhythmia monitors.	**8**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to
CO1: Understand the characteristics & analysis of EEG signal
CO2: Acquire and Analyse sleep EEG signals
CO3: Understand the principle & application of adaptive filter in acquiring physiological signals
CO3: Cancel the effects of ECG signals in other physiological signals of interest
CO4: Filter the interferences caused in ECG signal and the nature of the noise
CO5: Analysis of ECG signals

Cos	Mapping with Pos
CO1	PO1,PO2,PO4, PO6, PO7,PO12
CO2	PO2,PO3,PO4,PO6, PO7, PO12
CO3	PO2,PO3,PO4, PO6, PO7, PO12
CO4	PO2,PO3,PO4, PO6, PO7, PO12
CO5	PO2,PO3,PO4,PO6, PO7, PO12

TEXT BOOKS:

1. **Biomedical Digital Signal Processing**,Willis J.Tompkins, PHI.
2. **Biomedical Signal Processing- principles and techniques**, Tata McGraw-Hill, D.C.Reddy, 2005.
3. **Biomedical Signal Analysis**, Rangaraj M. Rangayyan, IEEE Press, 2001.
4. **Wavelet Transforms** , Raghuveer M. Rao and Ajit S. Bopardikar, Pearson, 1998.

REFERENCE BOOKS:

1. **Biomedical Signal Processing ,**Akay M, Academic Press ,1994
2. **Biomedical Signal Processing ,**Cohen.A, Vol. I , CRC Press, 1986.

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title: DIGITAL IMAGE PROCESSING		
Sub Code: ML72	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVE: To enable the students to study

1. To discuss the fundamental concepts of digital image processing
2. To discuss the various image transform with respect to basic functions, properties and application.
3. To discuss image enhancement technique in spatial and frequency domain.
4. To discuss image segmentation and restoration technique in spatial and frequency domain

UNIT No	Syllabus Content	No of Hours
1	**DIGITAL IMAGE FUNDAMENTALS** Background, digital image representation, examples of field that use DIP, fundamental steps in digital image processing, Simple image model, basic relationships between pixels: neighborhood of a pixel, Connectivity , Basic transformations: translational, rotational, scaling.Color models and transformations, Pseudo color Image Processing .	10
2	**IMAGE TRANSFORMS** Introduction to 2D Transforms: Fourier Transform and Properties, DCT and Properties, Hadmard Tranform and Properties , WHT and properties Image compression: Fundamentals, image compression models, elements of Information theory, Image Compression: lossy and non lossy compression, image compression standards.	10
3	**IMAGE ENHANCEMENT SPATIAL DOMAIN:** Background, Basic gray level transformations, histogram: Computation histogram, histogram specification, histogram equalization, enhancement using arithmetic/logic operations, basics of spatial filtering, smoothing sharpening spatial filters, combining spatial enhancement methods. Edge Detection Methods: Prewit, Sobel and Robert **FREQUENCY DOMAIN** Background, introduction to the frequency domain, smoothing and sharpening frequency domain filters, homomorphic filtering, generation of spatial masks from frequency domain specifications.	12
4	**IMAGE SEGMENTATION:** Detection of discontinuities, edge linking & boundary detection, thresholding , Region based segmentation, morphological watersheds, the use of motion in segmentation	10
5	**IMAGE RESTORATION** Degradation model, Noise models, restoration in the presence of noise only (Spatial and frequency domain filters), Inverse filtering, LMS filtering, Wiener filter, constrained least square restoration, interactive restoration, restoration in the spatial domain	10

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Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to

CO1: Understand the basic image processing concepts such as relationship between pixels, basic transformation and color models.
CO2: Implement 2-D image transforms such as DFT, DCT, HT,WHT.
CO3: Perform image compression using lossy and lossless techniques.
CO4: Implement image enhancement techniques in spatial & frequency domain.
CO5: Perform image segmentation and image restoration.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3
CO3	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12
CO4	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12

TEXT BOOKS:

1. **Digital Image Processing** , R C Gonzalez & R E Woods, Pearson Education, 3 edition.
2. **Digital Image Processing and Computer Vision** , Milan Sonka, Cengage learning, First edition.

REFERENCE BOOKS:

1. **Digital Image Processing** , S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata Mcgraw Hill, 2009.
2. **Fundamentals of Digital Image processing** , A K Jain, PHI / Pearson Education, 1989.
3. **Digital Image Processing** , Sid Ahmed, McGraw Hill.

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ELECTIVE 3 (GROUP C)

Sub Title: SPEECH PROCESSING		
Sub Code: ML731	**No. of Credits: 3=3:0:0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. Speech Producing Mechanism and classification of speech signals
2. Quantization of Speech signals
3. Various characteristics of the speech signal
4. Speech Synthesis and Recognition

UNIT No	Syllabus Content	No of Hours
1	**DIGITAL MODELS FOR SPEECH SIGNALS:** Process of Speech Production, Lossless tube models, and Digital models for Speech signals. **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.	9
2	**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. Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function.	10
3	**LINEAR PREDICTIVE CODING OF SPEECH:** Basic principles of linear predictive analysis, Solution of LPC equations, and Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Applications of LPC parameters	7
4	**SPEECH SYNTHESIS** Principles of Speech synthesis, Synthesis based on waveform coding, analysis synthesis method, speech production mechanism, Synthesis by rule, Text to speech conversion.	7
5	**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.	6

Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: By the end of the course the student will be able to

CO1:Understand the human physiological sound producing system and the different speech models
CO2:Interpret and extract various parameters of interest from speech spectrogram
CO3:Generate speech synthesizing and recognizing processes
CO4:Develop speech applications and algorithms for speech impaired persons

COs	Mapping with POs
CO1	PO1,PO2,PO4
CO2	PO1,PO2,PO3,PO4,PO5
CO3	PO1,PO2,PO3,PO4,PO5
CO4	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12

TEXT BOOKS:

1. **Digital Processing of Speech Signals,** L R Rabiner and R W Schafer, Pearson Education 2004.
2. **Digital Speech Processing- Synthesis and Recognition,**Sadoaki Furui, Mercel Dekker, Second Edition, 2002.

REFERENCE BOOKS:

1. **Introduction to Data Compression**,Khalid Sayood, Elsivier Publications, Third Edition
2. **Digital Speech**, A M Kondoz, Wiley Publications, Second Edition.

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Sub Title: BIOMATERIALS & ARTIFICIAL ORGANS		
Sub Code: ML732	**No. of Credits:3=3:0:0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. To know about various synthetic biomaterials.
2. To know about composite biodegradable polymeric and tissue derived material.
3. To understand the various artificial organs such as artificial heart, artificial kidney artificial lung.

UNIT No	Syllabus Content	No of Hour
1	**BIOMATERIALS:** Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials. **METALLIC BIOMATERIALS:** Introduction, Stainless steel, Cobalt-Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants. **CERAMIC BIOMATERIALS:** Introduction, nonabsorbable /relatively bioinert bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic-manufacturing techniques. **POLYMERIC BIOMATERIALS:** Introduction, polymerization and basic structure, polymers used as biomaterials, sterilization, surface modifications to for improving biocompatibility.	**10**
2	**COMPOSITE BIOMATERIALS:** Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility. **BIODEGRADABLE POLYMERIC BIOMATERIALS:** Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, and biodegradation properties of synthetic biodegradable polymers. **TISSUE DERIVED BIOMATERIALS:** Structure and properties of collagen and collagen-rich tissues, biotechnology of collagen, design of resorbable collagen-based medical implant. 3D Printing	**7**
3	**ARTIFICIAL ORGANS INTRODUCTION:** Substitutive medicine, outlook for organ replacement, design consideration, evaluation process. **ARTIFICIAL HEART AND CIRCULATORY ASSIST DEVICES:** Engineering design, Engg design of artificial heart and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues- sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants. Cardiac Valve Prostheses: Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current	**8**

	trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.	
4	**ARTIFICIAL KIDNEY:** Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute removal.	**7**
5	**ARTIFICIAL LUNGS:** Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions.	**7**

NOTE 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: Completion of this course the student will be able to

CO1: Understand the different biocompatible materials such as metallic, ceramic and polymers.
CO2: Understand the biodegradable biomaterials
CO3: Identify different artificial implants and assistive devices for cardio-vascular system
CO4:Design of artificial organs such as heart, kidney and lung.

COs	**Mapping with POs**
CO1	PO1,PO3,PO6,PO7
CO2	PO1,PO2,PO3,PO4,PO6,PO7,PO8
CO3	PO1,PO2,PO3,PO4,PO6,PO7,PO8,PO12
CO4	PO10,PO11,PO12

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TEXT BOOK:

1. **Biomedical Engineering Handbook**, J.D.Bronzino ,CRC Press ,Volume1 ,2nd Edition, 2000.
2. **Biomedical Engineering Handbook,** J.D.Bronzino ,CRC Press ,Volume2 ,2nd Edition, 2000.
3. **Handbook of Biomedical Instrumentation ,** R.S.Khandpur **,**Tata McGraw Hill, 2nd Edition , 2003.

CHAIRMAN/BOS DEAN(ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

Sub Title: PICTURE ARCHIVING AND COMMUNICATION STANDARDS		
Sub Code: ML733	**No. of Credits : 3**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours: 39**

COURSE OBJECTIVES: To enable the students to study

1. Technical requirements & financial implication to maintain PACS
2. Image processing fundamentals and medical imaging
3. Medical data storage & recovery

UNIT No	Syllabus Content	No. of Hours
1	**Introduction to PACS:** Interpretation Workstations, Strategic Plan, PACS Impact Analysis, Financial Analysis, Technical Requirements, Project Planning and Evaluation, Contract Negotiations .DICOM Standard, Queuing Perspective, Quality Assurance, HL7, IHE.	7
2	**Computer Fundamentals:** Digital Imaging Fundamentals, Image Acquisition, Image Processing Algorithms, Quality Assurance, Future trends, Image Compression, Compression Applications to medical imaging.	8
3	**PACS Architecture**: Centralized model, Medical-legal Archive, Networking Fundamentals, Factors to consider in building a network**.** **Servers and Operating Systems:** Disaster recovery, Storage and enterprise archiving, RAID, Direct attached storage, Storage area network, Hierarchical storage.	8
4	**Image Displays:** Digital Mammography, Web distribution. **PACS Workstation Software**: Role of Workstation, User Interface, Future of Workstations, Breast Imaging, CAD, CASS.	8
5	**3 Dimensional Imaging In Radiology**: Voice recognition, Order entry in Radiology. **Tele Radiology:** Image Acquisition and Image Digitization, Image Transmission, Applications of Tele Radiology, Legal and Socioeconomic Issues ACR Standards.	8

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course, the students would have learnt to

1. Explain the fundamental concepts of PACS and DICOM standards.
2. Apply the various operations performed on digital image
3. Understand the architecture of a typical PACS and requirements for implementations
4. Apply display techniques for medical images.
5. Apply the PACS in different domains of medical imaging and radiology

COs	Mapping with POs
CO1	PO2, PO3, PO4, PO6
CO2	PO2, PO3, PO4, PO12
CO3	PO2, PO3, PO4,
CO4	PO2, PO3, PO4,
CO5	PO2, PO3, PO4, PO6, PO12

TEXT BOOKS:

PACS – A guide to the Digital Revolution- Keith Dreyer – Springer, 2006.

REFERENCE BOOKS:

PACS in Medicine by H.K.Huang, Wiley-IEEE, 2004.

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ELETIVE 4 (GROUP D)

Sub Title: BIOSTATISTICS & RESEARCH METHODOLOGY		
Sub Code: ML741	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To enable the student to learn

1. The statistical data analysis and bio statistical analysis
2. Systematic approach to research studies
3. Various data analysis model

UNIT No	Syllabus Content	No of Hours
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.	**10**
2	**Introduction to Research methodology:** Meaning of research, objectives of research, motivation in research, types of research, research approaches, Research methods versus methodology, Defining research problem: selecting the problem, defining the problem, techniques involved in defining a problem, meaning of research design, need for research design, important concepts of research design	**12**
3	**ESTIMATION:** Introduction, confidence interval for population mean, t-distribution, confidence interval for difference between two population means, population proportion and difference between two population proportions, determination of sample size for estimating means, estimating proportions, confidence interval for the variance of normally distributed population and ratio of the variances of two normally distributed populations. **HYPOTHESIS TESTING :** Introduction, hypothesis testing – single population mean, difference between two population means, paired comparisons, hypothesis testing-single population proportion, difference between two population proportions, single population variance, ratio of two population variances.	**14**
4	**ANALYSIS OF VARIANCE (ANOVA):** Introduction, completely randomized design, randomized complete block design, factorial experiment. **LINEAR REGRESSION AND CORRELATION:** Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient.	**12**
5	**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.	**7**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: Completion of this course the student will be able to

CO1: Understand the basic concepts of biostatistics & research methodology.
CO2: Apply estimation & hypothesis technique for human health.
CO3: Apply Statistical analysis model like ANOVA, regression, chi-square

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4
CO3	PO1,PO2,PO3,PO4

TEXT BOOK:

1. **Biostatistics-A Foundation for Analysis in the Health Sciences** , Wayne W. Daniel, John Wiley & Sons Publication, 6th Edition.
2. **Research Methodology**, C R Kothari, New Age International Publishers, Second Revised Edition.

REFERENCE BOOKS:

1. **Principles of Biostatistics,** Marcello Pagano and Kimberlee Gauvreu, Thomson Learning Publication, 2006.
2. **Introduction to Biostatistics,** Ronald N Forthofer and Eun Sul Lee, Academic Press
3. **Basic Biostatistics and its Applications,** Animesh K. Dutta 2006.

CHAIRMAN/BOS DEAN(ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

Sub Title: MEDICAL DEVICES AND REGULATIONS		
Sub Code: ML742	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No. of lecture hours/week:04**
Exam Duration:3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To enable the students to study

1. Device types, Regulations and Standards and approval process of Medical Devices
2. Knowledge of FDA terminologies
3. Validation process for medical device hardware and software

Unit No.	Syllabus Contents	No. of Hours
1	Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposal Reliability: Concept of Failure: Various methods of CAPA Safety and Risk Management: Personnel safety and hygiene, Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device, The risk management processes, Shared responsibility for medical device safety and performance. Electrical safety and different standards Testing and verification of medical devices.	**9**
2	**The Food and Drug Administration:** Device classification, Registration and listing, The 510 (k) Process, Declaration of conformance to a recognized standard, The PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices (GMPs), Human Factors, Design Control, The FDA and Software, Software classification, The FDA Inspection ***The European Union:*** European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN)	12
3	**Standards and Regulations Background** ***Standards:*** Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards, The ISO 14000 Series of Standards, **The Medical Devices Directives:** The Medical Devices Directives process, Choosing the appropriate directive, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, *In-vitro* Diagnostic Medical Devices Directives. NABH, NABL, JCI, AERB , WHO guidelines on medical devices	10
4	**Software and Quality System Regulation** Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International Software Standards,	9

	Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action	
5	**Medical Device Testing** The basis and types of testing, Parsing test requirements, Test protocol, Test methodology, Purpose of the test, Failure definition, Determining sample size and test length, Types of testing. **Validation:** Hardware verification and validation, Software verification and validation,	12

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Define the medical device, its processes encompassing safety and risk management.
CO2: Identify the objectives and functions of FDA and EU.
CO3: Analyze various medical device standards and regulations
CO4: Document the procedure in software quality system regulations
CO5: Implement test protocol for medical device testing.

COs	Mapping with POs
CO1	PO1,PO4,PO6
CO2	PO1,PO6,PO7,PO8
CO3	PO1,PO5,PO6,PO7,PO8

TEXT BOOKS

1. **Reliable Design of Medical Devices**, Second Edition by Richard Fries, CRC Press, 2006.
2. **Medical Device Quality Assurance and Regulatory Compliance** , Richard C Fries, CRC Press, 1998.

REFERENCE BOOKS

1. **Medical device regulations: global overview and guiding principles** , Michael Cheng, World Health Organization.
2. **Product Safety in the European Union** , Gábor Czitán, Attila Gutassy, Ralf Wilde, TÜV Rheinland Akadémia, 2008.

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title: HOSPITAL DESIGN AND MANAGEMENT		
Sub Code: 743	**No. of Credits : 4**	**No of lecture hours/week : 4**
Exam Duration : 3 hours	**CIE +Assignment +SEE =45+5+50=100**	**Total no of contact hours: 52**

COURSE OBJECTIVES: To enable the students to study

1. The hospital plan for construction with all the essential hospital facilities
2. The design details of radiation services, nursing & operation departments
3. Providing electrical & water services and waste management
4. Safety & security issues

UNIT No	Syllabus Content	No of Hours
1	**Planning & Building a New Hospital:** Role of Hospital in Health Care, Hospital Planning & Design, Guiding principle in Hospital facilities & services, Functional Plans for Hospital construction, Design items, Functional program & design stage, Planning the Hospital building.	**10**
2	**Effective Hospital Management**: Planning, Organization, Directing & Leading, Controlling, Financial Management Administrative Service: Medical Record, Hospital Infection, Hospital Utilization Statistics, Material Management, Evaluation of Hospital services.	**10**
3	**Planning & Designing Medical Services**: Out Patient service, Emergency service, Clinical laboratories, Radiology services, Radiation Therapy Department, Surgical Department, Nursing Department, Operation Theater, CSSD Nursing services.	**10**
4	**Planning & Designing Engineering Services:** Engineering Department, Maintenance management, Clinical [Bio-medical] Engineering, Electrical System, Air Condition System, Water supply & sanitary system, Centralized Medical Gas System, Telecommunication System, Environmental Control, Safety & Security System, Disposal of Hospital Wastes.	**12**
5	**Planning & Design of Supportive Services:** Admitting Department, Medical Record Department, Centralized Sterilization & Supply department, Pharmacy Material Management, Food service.	**10**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

Course Outcomes: On Completion of this course the students will be able to
1. Design the hospital layout with an effective administration and financial management.
2. Plan and develop an effective hospital supportive system for all types of hospital services.
3. Evaluate the proper functioning and services provided by the hospitals
4. Plan and design providing essential services considering safety, security & waste disposal

COs	Mapping with POs
CO1	PO3, PO11
CO2	PO3, PO6
CO3	PO3, PO6
CO4	PO3, PO6

TEXTBOOK :

1. **Principles of Hospital Administration & Planning** - by B. M.Sakharkar, Jaypee Publications, 1998.
2. **Hospital Facilities, Planning & Managemen**t - by G. D. Kunders, Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. **Hospital Administration & Management** - by S. L. Goel & R. KumarDeep & Deep Publications
2. **Applied Clinical Engineering** - by Barry N. Feinberg, Prentice Hall,1984.
3. **Clinical Engineering Principle & Practices** - By John G. Webster &Albert M. Cook, Prentice Hall.

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title : BIO-MEDICAL DIGITAL SIGNAL PROCESSING LAB		
Sub Code: MLL75	**No. of Credits:2=0: 0:2(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to study

1. Signal conditioning of Biomedical signals using FIR and IIR filters and to plot and observe the nature of these signals using MATLAB.
2. And familiarize with the basic concepts of image processing such as enhancement and segmentation using MATLAB.

UNIT No	Syllabus Content
	Biomedical Signal Processing using MATLAB
1	Analysis of ECG data: Original signal, Noise signal and filtered signal
2	Realization of IIR and FIR filters for ECG
3	PSD estimation for ECG, EEG, and EMG
4	R-R interval sequence interpretation
5	Analysis of Real time ECG, EEG signals acquired through Power Lab data acquisition system
	Image Processing using MATLAB
6	Basic operations on an image: Logical operations, Resizing, Rotation, Translation, Negative of an image
7	Plotting Histogram and histogram equalization
8	Image Segmentation: Threshold, multiple threshold
9	Implementation of spatial domain filters: LP, Median, HP
10	Implementation of edge detection using gradient filters.
11	Display of bit planes of an image
Open End Experiment	

COURSE OUTCOME: The student will be able

CO1:To analyze and handle any biomedical signal. Interpret the signals and perform computation depending on the application, to perform any kind of image processing technique using MATLAB, to analyze and build any kind of application.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title: SEMINAR		
Sub Code: MLS76	**No of Credits 02:00:00**	**No of lecture hours/week :**
	Exam Marks : 50	

Course Objectives: To enable the students to learn

1. Read and disseminate technical papers
2. Prepare and present a document before the peers
3. Understand the latest happenings in their field of interest

The seminar topics must relate to the current trend in technology depending on the students interest in the field of medical electronics. And the students must carry out an elaborate literature survey on the related field referring standard international journals/conferences. The students will finally make a oral presentation and also submit a technical report.

COURSE OUTCOME: To enable the students to learn
CO1: Read and interpret technical papers
CO2: Express the ideas and communicate clearly
CO3: Prepare Technical documentation

COs	Mapping with POs
CO1	PO2,PO3,PO4,PO6
CO2	PO10
CO3	PO10,PO12

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Sub Title: PROJECT PHASE I		
Sub Code: MLP77	**No of Credits 0:00:00**	**No of lecture hours/week :**
	Exam Marks :	

COURSE OBJECTIVES: To enable the students to learn

1. Develop their own ideas
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I. The students will make a presentation of the abstract and synopsis and also submit a report showing the design & implementation along with the literature survey.

COURSE OUTCOME: The students will be able to

CO1: Carry out the literature survey
CO2: Convert the ideas of their interest into a conceptual model
CO3: Interact with outside world in identifying a suitable problem
CO4: Prepare proposals and approach funding agencies

COs	**Mapping with POs**
CO1	PO2,PO3,PO4,PO5, PO6, PO7, PO12
CO2	PO3, PO6, PO12
CO3	PO9,PO10, PO12
CO4	PO10, PO11,

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INTER DEPARTMENT ELECTIVE 1(GROUP E)

Sub. Title : BIO-MEDICAL ENGINEERING		
Sub Code: MLE01	**No of Credits : 04:00:00**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**Exam Marks : 100**	**Total No. of Contact Hrs: 52**

COURSE OBJECTIVES : To enable the student to learn

1.The nature of various physiological signals.
2.The measurement of blood pressure, pulse rate etc. and cardiac pacemakers & defibrillators
3.The basics of auditory mechanisms and the hearing aids & surgical systems.
4.The medical imaging modalities such as ultrasonic and MRI

Unit No	**Syllabus Content**	**No of Hours**
1	**FUNDAMENTAL CONCEPTS:** Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, General constraints in design of medical instrumentation systems. Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG. EOG, EGG,	**10**
2	**BIOMEDICAL RECORDERS:** Electrocardiograph-block diagram description, ECG leads, Artefacts, blood pressure measurement: korotkoff's method measurement of respiratory rate: Impedance Pneumograpy. OXIMETERS: Principle, pulse oximeter, Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker, Implantable Pacemaker, Types of implantable pacemaker, defibrillators: Need for defibrillators and dc defibrillators	**12**
3	**AUDIOMETER AND HEARING AIDS:** Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, hearing aids- conventional, digital hearing aid, cochlear implants. **VENTILATORS:** Mechanics of respiration, artificial ventilation, ventilators,	**10**
4	**INSTRUMENTS OF SURGERY:** Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy, **HAEMODIALYSIS MACHINE:** Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine	**8**
5	**ULTRASOUND IMAGING:** Fundamentals of acoustic propagation - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, **ULTRASONIC DIAGNOSTIC METHODS :**Pulse echo systems- Amplitude	**12**

	mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), Colour Doppler flow imaging, **BASICS OF MAGNETIC RESONANCE IMAGING:** fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences	

Assignment Question from unit 1, 2 &3

Assignment 2 Question from unit 4 & 5

COs	Mapping with POs
CO1	PO1,PO2,PO4, PO6
CO2	PO1,PO2,PO3,PO4,PO6
CO3	PO1,PO2,PO3,PO4,PO6
CO4	PO1,PO4, PO12

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.
2. **Medical Instrumentation Application and Design,** John G WebsterJohn Wiley and Sons, New York 2004
3. **Principles of Medical Imaging**, Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992

REFERENCE BOOK:

4. **Biomedical Instrumentation and Measurement** – by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.

5. **BIO MEDICAL TRANSDUCERS AND INSTRUMENTS**, Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
6. **Introduction to Biomedical Equipment Technology** , Joseph J Carr and John M Brown , Pearson Education ,4th Edition , 2001.

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VIII SEMESTER

ELECTIVE 5 (GROUP F)

Sub Title: NEURAL NETWORK AND PATTERN RECOGNITION		
Sub Code: ML811	**No. of Credits:4=4:0:0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: The enable the students to learn

1. The concepts of biological neuron and analogy to the artificial neuron model
2. Different neural network architecture
3. Various learning paradigms and comparisons

UNIT No	**Syllabus Content**	**No of Hours**
1	**INTRODUCTION TO BIOLOGICAL NEURAL NETWORK:** Classic neuron, Bioelectric potential, Electrochemical mechanism of action potential, Nernst equation-electrochemistry give rise to electrical events, Membrane potential distributed model, Synaptic electrical events, slow potential theory of neurons. **ARTIFICIAL NEURAL NETWORK:** introduction to artificial neural network, model of a neuron, Types of activation function, neural networks viewed as directed graphs, architectural graph of a neuron with feedback, Network Architectures, Artificial intelligence and Neural Networks.	**10**
2	Learning Processes: Learning in context to neural Networks, learning paradigms, supervised & unsupervised learning, Five basic learning rules-Error correction Learning, Memory based learning. Hebbian learning, Competitive and Boltzmann learning, learning tasks, Memory, adaptation, Statistical nature of learning processes, Statistical learning theory.	**9**
3	**SINGLE LAYER PERCEPTION:** Introduction, Adaptive filtering problem, Unconstrained optimization techniques, Newton's method, Gauss-Newton method, Linear least square filter, Least mean square algorithm, Learning curves, Learning Rate, Annealing techniques, Perceptron, convergence theorem	**9**
4	**MULTILAYER PERCETRON:** Introduction, Some Preliminaries, Back propagation algorithm, XOR Problem, Heuristics for making the back propagation algorithm perform better, Feature detection, Hessian matrix, generalization, Cross validation, Virtues and limitations of back propagation algorithm.	**12**

5	**Random Variables-**Binomial distribution, Poission distribution Continuous Random variables uniform density, exponential density, normal density **Introduction to pattern Recognition** **Statistical Decision Making:** Introduction, Bayes' theorem, multiple features, conditionally independent features, Decision boundaries: Two Dimensional decision boundaries **Clustering:** Introduction, Hierarchical clustering-agglomerative, single linkage, average linkage, ward's method. Partitional clustering-Forgy's, k-means,	**12**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to

CO1: Understand the concepts of artificial intelligence and neural network.
CO2: Understand the different learning algorithms and neural network architecture
CO3: Apply perceptron and multiple perceptron for classification
CO4: Apply the probabilistic models for data classification

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4, PO6, PO7
CO2	PO2,PO3,PO4, PO6, PO7,PO12
CO3	PO2,PO3, PO4, PO6, PO7,PO12
CO4	

TEXT BOOKS:

1. **An Introduction To Neural Networks,** James A. Anderson, PHI, 2nd edition ,1995.
2. **Neural Networks**, Simon Haykin Pearson Education/PHI, 2001.
3. **Neural Networks** , Satish Kumar, Tata Mcgraw-hill 2009
4. **Pattern Recognition & Image Analysis**, Earl Gose, Richard Johnsonbaugh Steve Jost, Prentice Hall of India, 2002.

REFERENCE BOOKS:-

1. **Introduction To Artificial Neural Systems**, Jacck M Zurada, Jaico publishing
2. **Artificial Neural Networks**, B Yegnanarayana, PHI, 2001
3. **Pattern Recognition**, Robert Schalkoff, Wiley India Pvt. Ltd.

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title: BIOSENSORS AND BIOMEMS		
Sub Code: ML812	**No. of Credits:4=4:0:0(L-T-P)**	**No of lecture hours/week: 4**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To study

1. The components used for various biosensors and biosensor family.
2. The principles of different types of transducers.
3. The applications of biosensor in different fields.
4. Different types of photometric assay techniques.

UNIT No	Syllabus Content	No of Hours
1	**Transducers in Biosensors:** Various types of transducers; principles and applications - Calorimetric, optical, potentiometric / amperometric conductrometric/resistormetric, piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics based transducers. Chemiluminescences - based biosensors.	**10**
2	**Applications and Uses of Biosensors:** Bio-Sensors in Clinical Chemistry, Medicine and Health Care, biosensors for personal diabetes management, application of biosensors to environmental samples. Biochips and their application to genomics	**10**
3	**Introduction to Biomems and Biomaterilals:** BIOMEMS, The driving force behind biomedical applications, bio-compatiability, Silicon fabrication: Hard fabrication considerations, lithography, etching techniques, Thin film deposition process, ion implantation, substrate bonding. Biomaterials: Soft lithography, micro molding, smart polymers & hydrogels, nanomedicine, thick film technologies, polymers, physical properties, copolymers. **Microfluidic Principles**: Introduction, transport process, electrokinetic	**12**
4	**Microactuators & Drug Delivery:** Introduction, activation methods, microactuators for microfluids, equivalent circuit representation, drug delivery, Clinical laboratory medicine: introduction, chemistry, hematology, immunology, urine analysis. **Micro-Total-Analysis Systems:** Lab-On A-Chip, capillary electrophoresis arrays, cell, molecule & particle handling, surface modification, Microspheres**.**	**10**
5	**Emerging Bio-MEMS Technology:** introduction, Minimal invasive surgery, cardiovascular, neurosciences, diabetics, point-of-care diagnosis, cell-based biosensors, Oncology.	**10**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to
CO1: Understand the characteristics of types of bio transducer
CO2: Understand the general applications of biosensors in medicine & health
CO3: Understand the biomaterials and fabrication of Bio-MEMS
CO4: Understand the principle of micro drug delivery system
CO5: Apply the Bio materials for major health issues

COs	**Mapping with POs**
CO1	PO3,PO4,PO6,PO7
CO2	PO1, PO2, PO3,PO4,PO6,PO7,
CO3	PO1,PO2, PO3,PO4,PO6,PO7,
CO4	PO1,PO2, PO3,PO4,PO6,PO7,PO12
CO5	PO1,PO2,PO7, PO11,PO12

TEXT BOOKS:

1. **Biosensors**, Elizabeth A. H Hall - Open University press, Milton Keynes.
2. **Commercial Biosensors,** Graham Ramsay, John Wiley and son, 1998.

REFERENCE BOOKS:

1. **Biosensors,** Eggins.
2. **Biosensors** , AEG CASS , OIRL press, Oxford University.
3. **Transducers and Instrumentation**, Murthy D V S. ,Prentice Hall, 1995

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Sub Title: INFRARED IMAGING & APPLICATIONS		
Sub Code: ML813	**No of Credits : 4= 4: 0: 0 (L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the student learn

1. To Understand the scope and practice of the field of infrared imaging system
2. To Understand the basic techniques used in thermography
3. To Examine and grasp the principle of camera and image acquisition techniques
4. To identify and Demonstrate proficiency in developing applications

UNIT No	Syllabus Content	No of Hours
1	**Introduction to thermography:** History and evolution of thermography, Electromagnetic Spectrum, Principles of black body radiation laws: Blackbody, Plank's law, Wien's displacement law, Stefan Boltzmann Law, Emissivity, Kirchoff's law, IR absorption characteristics, Radiometric measurements.	10
2	**Heat Transfer Mechanisms and measurements:** Heat and Temperature, Heat Transfer Mechanism, Principle of Conduction, Convection and Radiation, Temperature measurements: Contact and Non contact.	10
3	**Principle of Infrared Camera:** Optics, Detectors, Scanning and Imaging, Detector performance parameters: Responsivity, Noise Equivalent Power, Specific detectivity, System performance parameters: Temperature range, Accuracy, Thermal sensitivity, 4 Bar Target, Minimum Resolvable Temperature Difference (MRTD), Calibration of IR camera.	12
4	**Passive and Active Techniques:** Passive Thermography, Active Thermography: Pulsed Thermography, Lock-in Thermography, Pulsed Phase Thermography, Vibro Thermography, Eddy current Thermography, Frequency Modulated Thermal Wave Imaging	10
5	**Applications:** Standards and Procedures, Diagnosis and Monitoring of Pain-Acupuncture-Breast Thermography and Detection of Breast Cancer-Other Medical Applications-Raynaud's Phenomenon- Pressure Ulcers.	10

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Identify the objectives and background of infrared imaging
CO2: Apply the temperature measurements for various applications
CO3: Demonstrate the working operation of IR Camera
CO4: Analyze the various thermography calibration procedure.
CO5: Design of basic thermography imaging procedure for various clinical applications

COs	Mapping with POs
CO1	PO1,PO6,PO7,PO8
CO2	PO2,PO3,PO5
CO3	PO1,PO2,PO7
CO4	PO7,PO11, PO12
CO5	PO10,PO11, PO12

TEXT BOOKS:

1. **Infrared Thermal Imaging: Fundamentals,** Michael Vollmer, Klaus-Peter Mollmann ,Research and Applications, John Wiley, 2010.
2. **Common sense approach to thermal imaging,** Holst, Gerald C. Washington, DC, USA: SPIE Optical Engineering Press, 2000.
3. **Infrared Imaging: A casebook in clinical medicine**, Francis Ring , Anna Jung , Janusz Zuber, IOP Publishing, Temple Circus, Temple Way, Bristol, BS1 6HG, UK 2015.

REFERENCE BOOKS:

1. **Medical Infrared Imaging**, Nicholas A. Diakides, Joseph D. Bronzino, CRC Press,2007

2. **Nondestructive Evaluation of Materials by Infrared Thermography**, Xavier P.V. Maldague, Springer Science & Business Media

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ELECTIVE 6 (GROUP G)

Sub Title: BIOMETRIC SYSTEMS		
Sub Code: ML821	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To enable the students to Study

1. To understand the technologies of fingerprint, iris, face and speech recognition
2. To understand the general principles of design of biometric systems and the underlying trade-offs.
3. To recognize personal privacy and security implications of biometrics based identification technology.
4. To identify issues in the realistic evaluation of biometrics based systems.

UNIT No	Syllabus Content	No of Hours
1	**Introduction to Biometrics** Introduction and back ground biometric technologies passive biometrics active biometrics - Biometrics Vs traditional techniques Benefits of biometrics - Operation of a biometric system Key biometric processes: verification, identification and biometric matching. Development of biometric authentication. Basic terms, biometric data, biometric characteristics, biometric features, biometric templates and references. Performance measures in biometric systems: False Accept Rate (FAR), False Reject Rate (FRR), Failure To Enroll (FTE) Rate, Failure To Acquire (FTA) rate and- Need for strong authentication Protecting privacy and biometrics and policy Biometric applications	10
2	**Fingerprint Identification Technology** Fingerprint capture, sensor types, latent fingerprints. Fingerprint image preprocessing, segmentation, binary and skeletal images. Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint singularities, detection of loops, deltas, whirls and cores. Fingerprint Matching: Fingerprint Classification, Matching policies. Galton's details, base and complex minutiae, detection of minutiae. Fingerprint recognition, minutiae- and correlation-based methods. Fingerprints in forensics and biometrics, similarities and differences.	12
3	**Face Recognition:** Introduction to the face processing pipeline: acquisition, face detection, alignment, feature extraction, matching. Classic subspace methods. Hand-tuned feature descriptors. Distance, similarity and learning-based matching. components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and	12

	3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.	
4	**Voice Scan:** Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration.	**10**
5	**Fusion in Biometrics:** Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multibiometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion. Examples biopotential and gait based biometric systems.	**08**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to
CO1: Identify the objectives and background of biometrics
CO2: Determine fingerprint identification techniques.
CO3: Demonstrate knowledge engineering principles underlying face recognition.
CO4: Analyze various speech features and models for speaker recognition system
CO5: Design of basic biometric system applications.

COs	**Mapping with POs**
CO1	PO1,PO3,PO4, PO6, PO7,
CO2	PO1,PO2,PO3,PO4, PO6, PO7, PO12
CO3	PO1,PO2,PO3,PO4,PO12
CO4	PO1,PO2,PO3,PO4,PO12

TEXT BOOKS:

1. **Fundamentals of BioMEMS & Medical Microdevices**, Steven Salitreman, Cengage Learning India, 2006.
2. **Lab-On-A-Chip: Miniaturized systems for chemical analysis & synthesis**, Edwin ooterrbroek, Alert Berg, Elsevier, 2003.

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Sub Title: REHABILITATION ENGINEERING		
Sub Code: ML822	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+ Assignment +SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To enable the students to Study

1. Concept of Rehabilitation, Diagnosis of disability.
2. Rehabilitation team role of physiatrist.
3. Therapeutic exercise technique.
4. Principle in Management of communication.
5. Orthotic devices in Rehabilitation Engg. and to know about level of amputation.
6. Prosthetic device and mobility aids.

UNIT No	Syllabus Content	No of Hour
1	**INTRODUCTION TO REHABILITATION & REHABILITATION TEAM:** What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Physiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Effects of prolonged inactivity & Bed rest on body system. REHABILITATION TEAM**:** Classification of members, The Role of Physiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer.	**12**
2	**THERAPEUTIC EXERCISE TECHNIQUE :** Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.	**7**
3	**PRINCIPLES IN MANAGEMENT OF COMMUNICATION:** Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.	**7**
4	**ORTHOTIC DEVICES IN REHABILITATION ENGINEERING:** General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Biomechanics of orthoses, merits & demerits of orthotics, Material design consideration in orthotics, Calipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbo sacro orthosis, Splints-its functions & types. **AMPUTATION:** Levels of Amputation – Surgical process, Expected Outcomes, Post operative dressings – Rigid dressings, Semi rigid dressings, Soft dressings, Examination- Range of Motion, Muscle Strength, Status of Residual Limb, Status of the un involved limb, Functional status, emotional status.	**13**
5	**PROSTHETIC DEVICES:** Introduction, Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction	**13**

	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. Post cardiac operation rehab	

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: The student will be able to

CO1: Understand the concept of rehabilitation and the role of rehabilitation team.
CO2: Implement and suggest therapeutic exercise techniques.
CO3: Understand aphasia and suggest different visual aids,hearing aids and writing aids.
CO4: Design and develop orthotic and prosthetic devices.
CO5: Differentiate between the different mobility aids.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4,PO7,PO8,PO12
CO3	PO1,PO2,PO3,PO4,PO7,PO8,PO12

TEXT BOOKS:

1. **Rehabilitation Medicine,** Dr. S. Sunder, Jaypee Medical Publications, New Delhi.
2. **Physical Rehabilitation**, Susan B O'Sullivan, Thomas J Schmitz. 5th edition

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Sub Title: PROGRAMMING WITH PYTHON		
Sub Code: ML823	**No. of Credits : 4**	**No of lecture hours/week : 4**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no. of contact hours: 52**

COURSE OBJECTIVES: To enable the students to Study

1. Understanding the syntax and semantics of the Python language.
2. To create Functions in Python.
3. To handle Files & Regular expressions in Python.
4. To apply Object Oriented Programming concepts in Python.

UNIT No	Syllabus Content	No of Hou
1	Introduction to Python Programming: Variables, Expressions and Statements: Values and types, Variables, Variable names and keywords, Statements, Operators and operands, Expressions, Order of operations, Modulus operator, String operations, Asking the user for input, Comments, Choosing mnemonic variable names. Conditional Execution: Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, Catching exceptions using try and except, Short circuit evaluation of logical expressions.	10
2	Functions Iteration, Strings : Function calls, Built-in functions, Type conversion functions, Random numbers , Math functions, Adding new functions, Dentitions and uses, Flow of execution, Parameters and arguments, Fruitful functions and void functions, Why functions? Iteration: Updating variables, The while statement, Infinite loops and break, Finishing iterations with continue, Definite loops using for, Loop patterns. Strings: A string is a sequence, Getting the length of a string using len, Traversal through a string with a loop, String slices, Strings are immutable, Looping and counting, The in operator, String comparison, String methods, Parsing strings, Format operator.	**10**
3	Files ,Lists, Dictionaries, Tuples, Regular Expressions: Persistence, Opening files, Text files and lines, Reading files, Searching through a file, Letting the user choose the file name, Using try, except, and open, Writing files. 9 Lists: A list is a sequence, Lists are mutable, Traversing a list, List operations, List slices, List methods, Deleting elements, Lists and functions, Lists and strings, Parsing lines, Objects and values, Aliasing, List arguments. Dictionaries: Dictionary as a set of counters, Dictionaries and files, Looping and dictionaries, Advanced text parsing. Tuples: Tuples are immutable, Comparing tuples, Tuple assignment, Dictionaries and tuples, Multiple assignments with dictionaries, The most common words, Using tuples as keys in dictionaries, Sequences: strings, lists, and tuples. Regular expressions: Character matching in regular expressions, Extracting data using regular expressions, Combining searching and extracting, Escape character	**12**

4	**Classes and objects, Classes and functions, Classes and methods** User-defined compound types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying. Classes and Functions: Time, Pure functions, Modifiers, Prototyping development versus planning. Classes and Methods: Object-oriented features, Printing objects, Another example, A more complicated example, The init method, Operator overloading, Polymorphism.	**10**
5	**Linked Lists and Stack:** Embedded references, The Node class, Lists as collections, Lists and recursion, Infinite lists, The fundamental ambiguity theorem, Modifying lists, Wrappers and helpers, The Linked List class, Invariants. Stacks: Abstract data types, The Stack ADT, Implementing stacks with Python lists, Pushing and popping, Using a stack to evaluate postfix, Parsing, Evaluating postfix, Clients and providers. Queues: The Queue ADT, Lnked Queue, Performance characteristics, Priority queue, The Golfer class	**10**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: On Completion of the course the students should be able to:

CO1: Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.
CO2: Demonstrate proficiency in handling Strings and File Systems.
CO3: Create, run and manipulate Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.
CO4: Interpret the concepts of Object-Oriented Programming as used in Python.
CO5: Implement exemplary applications related to Network Programming, Web Services and Databases in Python.

COs	Mapping with POs
CO1	PO1, PO2, PO3, PO4, PO12
CO2	PO1, PO2, PO3, PO12
CO3	PO1,PO2,PO3, PO4, PO9
CO4	PO1,PO2,PO3, PO9
CO5	PO1, PO2,PO3,PO4, PO5, PO10, PO12

TEXT BOOKS:

1. **Python for Informatics** , Charles Severance, 1st Edition, CreateSpace Independent Publishing Platform, 2013.
2. **How to Think Like a Computer Scientist: Learning with Python** , Peter Wentworth, Jeffrey Elkner, Allen B. Downey, Chris Meyers 2nd Edition, Open Book Project, 2012.

REFERENCE BOOKS:

1. **Learning Python**, Mark Lutz, 5th Edition, O'Reilly Media, 2013.
2. **Core Python Applications Programming** Wesley Chun 3rd Edition, 2012
3.**Python in a Nutshell**, Alex Martelli, 2nd Edition, 2006 .
4. http://openbookproject.net/thinkcs/python/english2e/

CHAIRMAN/BOS **DEAN (ACADEMIC)** **CHAIRMAN/ACADEMIC COUNCIL**

Sub Title: PROJECT PHASE II		
Sub Code: MLP83	**No of Credits 12:00:00**	**No of lecture hours/week :**
	Exam Marks : 100	

COURSE OBJECTIVES: To enable the students to Study

1. Realise their technical ideas into a working mode
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I has to be implemented with the guidance of a teacher assigned to the batch. The students will finally make an oral presentation and also submit a technical report.

COURSE OUTCOME: The students will be able to
CO1: Realise innovative ideas into working models
CO2: Discuss ideas, plan and work in a peer team to develop a system
CO3: Design a cost effective model within the time
CO4: Interact with outside world
CO5: Document and present the technical project report

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO12
CO2	PO9,PO10, PO11,
CO3	PO11, PO12,
CO4	PO10
CO5	PO10, PO12

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INTER DEPARTMENT ELECTIVE 2 (GROUP H)

Sub Title: MEDICAL DEVICES SAFETY & REGULATIONS		
Sub Code: MLE02	**No of Credits : 04:00:00**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**Exam Marks : 100**	**Total No. of Contact Hrs. 52**

COURSE OBJECTIVES: To enable the students to study

1. Device types, Regulations and Standards and approval process of Medical Devices
2. Patient safety and precautions
3. Knowledge of FDA terminologies
4. Validation process for medical device hardware and software

UNIT No	Syllabus Content	No of Lecture Hours
1	**Classification of Device:** Device classes, **PATIENT SAFETY**: Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer. safety & precautions Safety aspects in electro surgical systems	**10**
2	**Safety Aspects in Medical Imaging systems:** Biological effects of ionizing radiation- Determinants of biological effects, Short term & long term effects Ultrasound bio-effects, Radio biology of nuclear medicine, biological effects of magnetic field Laser safety- fundamentals, safety consideration of lasers **Reliability**: Types of Reliability, Optimizing reliability, Reliability's effects on medical devices	**10**
3	**Definition:** Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposals **Concept of Failure**: Various methods of CAPA **Safety and Risk Management:** Personnel safety and hygiene, Medical device safety and risk management, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance. Electrical safety and different standards. Testing and verification of medical devices	**10**
4	**The Food and Drug Administration:** Device classification, Registration and listing, The 510 (k) Process, Declaration of conformance to a recognized standard, The PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices (GMPs), The FDA and Software, Software classification, The FDA Inspection **The European Union Directives:** European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification, Final documents from the GHTF, Global Medical Device	**12**

5	**Standards and Regulations Background:** Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. **The ISO 9000 Series of Standards, The Medical Devices Directives:** Definition of a medical device, The Medical Devices Directives process, Choosing the appropriate directive, Identifying the applicable essential requirements, Identification of corresponding harmonized standards, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, *In-vitro* Diagnostic Medical Devices Directives. NABH, NABL, JCI, AERB , WHO guidelines on medical devices	**10**

Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: Completion of this course the student would have learnt
CO1: Classify medical device, its processes encompassing safety and precautions
CO2: Identify the hazards in various modalities of imaging systems and adapt safety measures
CO3: Define the medical device, its processes and risk management.
CO4: Identify the objectives and functions of FDA and EU.
CO5: Analyze various medical device standards and regulations

Cos	**Mapping with Pos**
CO1	PO6, PO7, PO8
CO2	PO6,PO7,PO8
CO3	PO6, PO7, PO8
CO4	PO7,PO8, PO12
CO5	PO6, PO7, PO8, PO12

TEXT BOOKS:

1. **Reliable Design of Medical Devices**, Second Edition by Richard Fries, CRC Press, 2006.
2. **Medical Device Quality Assurance and Regulatory Compliance**, Richard C Fries, CRC Press, 1998.

REFERENCE BOOKS:

1. **Medical device regulations: global overview and guiding principles** , Michael Cheng, World Health Organization.
2. **Product Safety in the European Union** , Gábor Czitán, Attila Gutassy, Ralf Wilde, TÜV Rheinland Akadémia, 2008.

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