VII SEMESTER

Sub Title: Neural Network & Machine Learning		
Sub Code: 18MD71	**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: The student will understand

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. **ARTIFICIAL NEURAL NETWORK:** introduction to ANN, model of a neuron, Types of activation function, neural networks viewed as directed graphs, architectural graph of a neuron with feedback, Network Architectures.	8
2	**LEARNING PROCESSES**: Learning in context to neural Networks, learning paradigms, supervised & unsupervised learning, Five basic learning rules Hebbian learning, learning tasks, Memory, adaptation, Statistical nature of learning processes.	8
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.	7
4	**MULTILAYER PERCETRON:** Introduction, Some Preliminaries, Back propagation algorithm, XOR Problem, Hessian matrix, generalization, Cross validation.	8
5	**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. **CNN :** Introduction, architecture, application	8

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

COURSE OUTCOMES: The student would have learnt

CO1: The concepts of artificial intelligence and neural network.
CO2: The different learning algorithms and neural network architecture
CO3: To apply perceptron and multiple perceptron for classification
CO4: The probability and distribution of random variables
CO5: To apply clustering techniques to perform classification

COs	**Mapping with POs**
CO1	PO1,PO2,PO3,PO5
CO2	PO1,PO2,PO3,PO5,PO11,PO12
CO3	PO1,PO2,PO3,PO5,PO11,PO12
CO4	PO1,PO2,PO3
CO5	PO1,PO2,PO3,PO5,PO11,PO12

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: MEDICAL DEVICES REGULATIONS		
Sub Code: 18MD72	**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. 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	**Medical Device**: Definition, product definition process, overview of quality function deployment (QFD), QFD process, business proposal. **Reliability**: Concept of failure and various reliability. **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, risk management processes, shared responsibility for medical device safety and performance.	**7**
2	**The Food and Drug Administration:** Device classification, 510 (k) Process, Declaration of conformance, PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices (GMPs), Human Factors, Design Control. ***The European Union:*** European Directives, Conformity Assessment and Testing, European Organization for Testing and Certification, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN)	**8**
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, ISO 14000 Series of Standards. **The Medical Devices Directives:** 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.	**8**
4	**Software and Quality System Regulation** Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International Software Standards, Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance	**8**

	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,	**8**

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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
CO4	PO1,PO5,PO12
CO5	PO1,PO2,PO11,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** , Gabor Czitan, Attila Gutassy, Ralf Wilde, TUV Rheinland Academia, 2008.

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

Sub Title : BIO MECHANICS		
Sub Code: 18MD73	**No of Credits :3= 3: 0: 0(L-T-P)**	**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: Understand the mechanical aspects of human motion:

1. Quantitative and qualitative analysis of human motion and performance.
2. Use physical laws of motion to solve problems of human motion.
3. Understand the relationship between mechanical properties and anatomical functions.
4. Understand how biomechanical principles can be applied to examine human activities such as sport and orthopaedic rehabilitation.

UNIT No	Syllabus Content	No of Hours
1	**BIO-FLUID MECHANICS:** Newton's laws, stress, strain, elasticity, Hook's-law, viscosity, Newtonian Fluid, Non-Newtonian fluid, viscoelastic fluids. Vascular tree. Relationship between diameters, velocity and pressure of blood flow, Resistance against flow	**08**
2	**VISCOELASTIC FLUID:** Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models.	**08**
3	**RESPIRATORY MECHANICS:** Alveoli mechanics, Interaction of blood and lung P-V curve of lung. Breathing mechanism. Airway resistance. Physics of lung diseases.	**08**
4	**ORTHOPEDIC MECHANICS:** Mechanical properties of cartilage. Diffusion properties of articular, cartilage, Mechanical properties of bone. Kinetics and Kinematics of joints, Lubrication of joints. Fundamental concepts of Gait analysis.	**08**
5	**BIOMECHANICS INSTRUMENTATION**: Measuring principles of Cutometer, Durometer. Electrodynamometer, Microindentometer & Ballistometer.	**07**

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

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

CO1: Understand the concepts of bio-fluids.

CO2: Understand the various viscoelastic models.

CO3: Understand the concepts of respiratory mechanics

CO4: Understand the concept of orthopaedic mechanics.

CO5: Understand the principles of various biomechanics measuring equipments.

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

TEXT BOOKS:

1. **Biomechanics, Mechanical Properties of Living Tissues,**Y.C Fung,Springer Verlag, Edition2, 1993.
2. **Introduction to Biomechanics of Joints & Joint Replacement Mechanical Engg,** D.Dowson, V Wright publication, 1987.
3. **The Biomedical Hand Book**,Joseph.D.Bronzino ,CRC Press, 2nd Edition,2000.

REFERENCE BOOKS

1. **Applied Biofluid Mechanics**, Lee Waite, Jerry Fine, McGraw Hill publications, 2007 edition
2. **Biomechanics & exercise physiology** ,Arthur T Johnson,John Wiley & Sons publications

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

ELECTIVE 3 (GROUP C)

Sub Title: BIOSENSORS AND BIOMEMS		
Sub Code:18MD741	**No. of Credits:3=3:0:0(L-T-P)**	**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 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.	**7**
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	**8**
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	**8**
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**.**	**8**
5	**Emerging Bio-MEMS Technology:** introduction, Minimal invasive surgery, cardiovascular, neurosciences, diabetics, point-of-care diagnosis, cell-based biosensors, Oncology.	**8**

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

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

Sub Title: REHABILITATION ENGINEERING		
Sub Code: 18MD742	**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. 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 Hours
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. 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.	**8**
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. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Splints-its functions & types. **AMPUTATION:** Introduction to levels of Amputation	**9**
5	**PROSTHETIC DEVICES:** Introduction, Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction	**8**

	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.	

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
CO4	PO1,PO2,PO3,PO4,PO7,PO8,PO12
CO5	PO1,PO2,PO3,PO4,PO7,PO8,PO12

TEXT BOOK:

1. **Rehabilitation Medicine,** Dr. S. Sunder, Jaypee Medical Publications, New Delhi.

REFERENCE BOOK:

1. **Physical Rehabilitation**, Susan B O'Sullivan, Thomas J Schmitz. 5th edition

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

Sub Title: PICTURE ARCHIVING AND COMMUNICATION STANDARDS		
Sub Code: 18MD743	**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:

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

Reference Books:

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

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

ELECTIVE 4 (GROUP D)

Sub Title: BIOMATERIALS & ARTIFICIAL ORGANS		
Sub Code:18MD751	**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.	8
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.	8
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	8

	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 trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.	
4	**ARTIFICIAL KIDNEY:** Haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute removal. **Introduction to 3D Printing & Classification:** Basics Steps in 3D Printing, Difference between 3D Printing and conventional manufacturing, Benefits of 3D Printing, Classification of 3D Printing Process, and Applications.	**8**
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: Understand the artificial kidney and 3D printing technology.
CO5: Understand the artificial 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
CO5	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.

REFERENCE BOOKS

1. **Biomaterials A Basic Introduction,** Qizhi Chen, George Thomas, CRC Press
2. **Biomaterial Science an Introduction to material in medicine** (2nd Ed) New York Academic press

3. **Medical Modelling: The Application of Advanced Design and Rapid Prototyping**

Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing, 2017.

4. **Advanced Manufacturing Technology for Medical Applications**, Ian Gibson, John Wiley, 2005

5. Ian Gibson, David Rosen, Brent Stucker (auth.)-**Additive Manufacturing Technologies_ 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing**-Springer New York (2015).

Online Resources:

1. https://medicalfuturist.com/3d-printing-in-medicine-and-healthcare/
2. https://zortrax.com/applications/medicine/
3. https://www.frontiersin.org/articles/10.3389/fmech.2020.589171/full
4. https://www.nist.gov/additive-manufacturing
5. https://additivemanufacturing.com/basics/

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

Sub Title: BIOMETRIC SYSTEMS		
Sub Code: 18MD752	**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 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	**8**
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.	**8**
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 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses,	**8**

	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.	**8**
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.	**7**

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
CO5	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.

REFERENCE BOOKS

1. **Biometrics- The Ultimate Reference,** John D. Woodward, Jr. Wiley Dreamtech.1edition, 2003

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Sub Title: BIOMEDICAL NANOTECHNOLOGY		
Sub Code: 18MD753	**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 characterize Nano technology as a multitude of different approaches.
2. To know relationship between these laws and the extraordinary properties of nano-devices will be outlined.
3. To provide an insight into the chemical materials and fabrication.
4. To study adaptive filters and their applications in biomedical signal processing.

To demonstrate how the applications of Nano technology will influence science of tomorrow and will change many sides of our life.

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO NANO:** Bio ceramics for implant coating: calcium phosphates -hydroxy epilates Ti6Al4V and other biomedical alloys -implant tissue interfacing –metal organic CVD –use of tricalcium phosphate –biomimetic and solution based processing –osteo porosis –osteo plastic –regeneration of bones by using bio compactable ceramics –biointeractive hydro gels –PEG coating and surface modifications –PEG hyrogels patterned on surfaces –PEG based hyrogels.	**7**
2	**TISSUE ENGINEERING :** scaffolds for tissue fabrications –materials for scaffolds –materials for hydrogel scaffolds –scaffolds fabrications technologies –textile technologies –particulate –leaching techniques –phase separation –design of three-dimensional pore architecture –nano-featured and bioactive scaffolds –nano-fiber scaffolds –nanocomposite scaffolds –bioactive scaffolds –scaffolds for stem cells –micro and nanopatterned scaffolds -scaffolds and stem cells –Engineering biomaterial to control cell function –building structure into engineered tissues –fibrous proteins and tissue engineering.	**6**
3	**NANOMEDICINE:** Diagnosis of diseases, treating and preventing of diseases –targeted for drug delivery –ligand coupled nanoparticle features –methods for coupling targeting ligands to nanoparticles –targeting modalities –barriers to tumor targeting in vivo –MRI contrast enhancement -future line of action –Gene delivery –Bio molecular motors -Nanoscale transport systems: molecular shuttle powered by Biomolecular motors.	**9**
4	**NANOPHARMACY:** multi-targeted drugs –delivery of nucleic acids-barriers to therapeutic applications –interaction of organic molecules of the drug with pathological tissue –ligand targeted nanoparticles drug delivery: combining multiple functions -formation of nucleic acid core particle –protective steric coating –surface exposed ligands targeting specific tissues –biocompatible core-shell nanoparticles for medicine –configuration of core –shell structure with different cores, shells and biomolecules-least toxicity-nanocapsules-methods of changing surface characteristics-future prospects.	**9**

5	**BIOMEDICAL APPLICATIONS OF NANOTECHNOLOGY:** Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nano arti-cial cells, Nanotechnology in organ printing. Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology. Nanotechnology in point-of-care diagnostics.	**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 nanoscale structures using scientific and technological principles
CO2: Gain knowledge of various nanoscale fabrication and characterization techniques
CO3: Assess the present and ever-developing state-of-art biomedical nanotechnology in the areas of tissue engineering
CO4:Appraise the unique elements of nanostructured materials for biomedical applications

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

TEXT BOOKS:

1. **Nano Scale Science And Technology,** Robert.W.Kelsall, Ian.W.Hamley, Mark Geoghegan (Ed), Nano Scale Science And Technology, John Wiley and son, ltd., 2005
2. **BioMEMS and Biomedical Nanotechnology**, Volume I: Biological and Biomedical Nanotechnology; Editor-in-chief: Ferrari, Mauro; Lee, Abraham P.; Lee, James (Eds.), 1 edition, Springer (2006)Raghuveer M. Rao and Ajit S. Bopardikar, Pearson, 1998.

REFERENCE BOOKS:

1. **Micromachines As Tools For Nanotechnology**, Fujita (Ed), As Tools For Nanotechnology, Springer, 2003.
2. **The Handbook of Nanomedicine**, Jain, K.K., Humana press, 2008.

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Sub Title : JAVA LAB		
Sub Code: 18MDL77	**No. of Credits:1=0: 0:2(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES

To enable the students learn the fundamentals of programming language Java and also develop programming skills in Java

1	Simple Java Programs to illustrate the data operators
2	Program for string reversal
3	Program for demonstration of control statements
4	Program for demonstrating constructors
5	Program for demonstrating Overloading and overriding
6	Program for demonstrating multilevel Inheritance
7	Program for exception handling (try & catch methods and nested try statement and)
8	Program for demonstrating event handling
9	Developing Applet program

COURSE OUTCOME: The students would have

CO1: Acquired programming skills in Java and will be able to develop applications using Java

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

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Sub Title: Project Phase I		
Sub Code: 18MDP78	**No of Credits 2:00:00**	**No. of Hours/Week : 02**

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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OPEN ELECTIVE – GROUP C

Sub Title: MEDICAL DEVICES SAFETY & REGULATIONS		
Sub Code: 18MD761	**No of Credits : 03:00:00**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**Exam Marks : 100**	**Total No. of Contact Hrs: 39**

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, Regulatory controls applied to medical device. **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.	8
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.	8
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. Testing and verification of medical devices.	7
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 Nomenclature (GMDN).	8

5	**Standards and Regulations Background:** Standards development process, Identification of standards, Voluntary and mandatory standards, National and international standards. The ISO 9000 Series of Standards, Current trends in the use of standards in medical device regulations. **The Medical Devices Directives:** Definition of a medical device, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, The Medical Devices Directives process, Choosing the appropriate directive. *In-vitro* Diagnostic Medical Devices Directives. **Healthcare Organizations and Regulatory authorities:** NABH, NABL, JCI, AERB, WHO guidelines on medical devices.	8

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** , Gabor Czitan, Attila Gutassy, Ralf Wilde, TÜV Rheinland Akademia, 2008.

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VIII SEMESTER

Sub Title: PROJECT PHASE II		
Sub Code: 18MDP81	**No of Credits 10:00:00**	**No of Hours/Week : 04**
	CIE+SEE Marks :50+50.	

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: Realize 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 industry experts
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	PO4, PO5, PO11, PO12,
CO4	PO9, PO10,PO11, PO12
CO5	PO10, PO12

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Sub Title: SEMINAR		
Sub Code: 18MDS82	**No of Credits 01:00:00**	**No. of Hours/Week: 02**
	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: INTERNSHIP		
Sub Code: 18MDI83	**No of Credits 02:00:00**	
	Exam Marks : 100	

Course Objectives: To enable the students to

1. Understand the latest technology trends
2. Develop and refine skills
3. Explore the career path

The students must carry out the internship in the field related to medical electronics. The students have to complete four weeks of internship either in hospitals or any industry. The students have to finally make an oral presentation about the knowledge and exposure gained during the internship period. The students have to submit a detailed report.

Course Outcome: The student will be able to
CO1: Develop communication, interpersonal & problem solving skills
CO2: Integrate theory and implementation
CO3: Prepare Technical documentation

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

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