M.TECH
BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION
ACADEMIC YEAR 2013-15

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. TECH. BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION
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Total Credits (6 Theory + 1 Lab) 22

*Compulsory for students with ECE & EIE background*
## I YEAR II SEMESTER

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<td>Design and Analysis of Signal Conditioning Circuits</td>
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**Total Credits (6 Theory + 1 Lab) 22**
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## II YEAR – II SEMESTER

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UNIT-I
Digitized image functions, Dirac distributions, convolution, Fourier transform, Images as linear system. Image digitization, sampling, Quantization, color images. Digital image properties, Metric and topological properties, Histogram visual perception, Image quality, Noise. Data structures for image analysis, data representation, traditional and hierarchical data structures.

UNIT-II

UNIT-III
Thresholding and Segmentation. Detection methods, optimal thresholding, multi-spectral thresholding. Edge based segmentation, Region based segmentation, Matching, Advanced optimal border and surface detection approaches.

UNIT-IV

UNIT-V
Mathematical morphology. Basic morphological concepts, Morphological principles: Binary dilation and erosion, Gray scale dilation and erosion, skeletons and object marking, graundometry, Morphological segmentation and water sheds.

TEXTBOOKS:

REFERENCES:
REAL TIME SIGNAL PROCESSING

UNIT I
Review of Basics: Discrete time processing of continuous signals - Structure of a digital filter; Frequency domain analysis of a digital filter; Quantization error; Sigma and Sigma Delta Modulation. Fourier analysis – DFT, DTFT, DFT as an estimate of the DTFT for Spectral estimation. DFT for convolution, DFT/DCT for compression, FFT. Ideal Vs non ideal filters, FIR and IIR Filters Digital Filter Implementation; Elementary Operations.

UNIT II
Real Time Transforms: Discrete Cosine Transform, Walsh Transform, Hadamard Transform and Wavelet Transform.
Digital Filters – State Space realization, Robust implementation of Digital Filters, Robust implementation of equi – ripple FIR digital filters.

UNIT III
Multirate Signal Processing: Concepts of multirate signal processing, Software implementation of sampling rate converters – decimators and interpolators, Sample rate conversion using polyphase filter structure.

UNIT IV

UNIT V

TEXT BOOKS:

REFERENCE BOOKS:
VIRTUAL INSTRUMENTATION

UNIT- I
Virtual Instrumentation: An introduction
Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

UNIT- II
VI programming techniques:
VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT- III
Data acquisition basics:
Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. DC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT -IV
VI Interface requirements:
Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Fire wire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT- V
VI toolsets: Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

TEXTBOOKS

REFERENCES
1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
3. LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 199
UNIT-I
Principles of transduction and measurement, Sensor Classification, Medically significant measurands- strain, force, pressure, acceleration, flow, volume, temperature and biopotentials. Functional specifications of medical sensors; static and dynamic characteristics of measurement systems. Primary sensors.

UNIT – II

UNIT-III
Reaction variation and electromagnetic sensors. Capacitive sensors, inductive sensors, LVDT, electromagnetic sensors. Signal conditioning, AC bridges, AC amplifiers, electrostatic shields, carrier amplifiers, phase-sensitive detectors.

UNIT-IV

UNIT-V

TEXTBOOK:
REFERENCES:


UNIT I

UNIT II
Renal Physiology : Kidney, Nephron, Juxtaglomerular apparatus, Renal circulation, Urine formation, Concentration of urine, Acidification of urine, Renal function tests, Renal disorders, Micturition, Uro flow studies, Dialysis.

UNIT III
Cardiovascular System : Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle, Heart sounds, Cardiac murmurs, Electrocardiogram, Vector, Arrhythmia, Cardiac output, Regulation of heart rate, Hemodynamics, Arterial blood pressure, Hemorrhage.

UNIT IV

UNIT V
Muscle Physiology : Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction, Electromyogram & disorders of skeletal muscles. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.
TEXTBOOK:


REFERENCES:

2. Walter Boron, Textbook of Medical Physiology , Publisher: W.B. Saunders Company, 2008
UNIT I
The Central Dogma & XML (Bio XML) for Bioinformatics: Watson’s definition, information flow, from data to knowledge, Convergence, the organization of DNA, the organization of Proteins.
Introduction, Differences between HTML and XML, fundamentals of XML, fundamentals of XML namespaces. Introduction to DTDs, Document type Declarations, Declaring elements, declaring attributes, working with entities XML Schemas, Essential Concepts, working with simple types, working with complex types, Basic namespaces issues.

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

UNIT III
Databases: Flat file, Relational, object oriented databases, object Relational and Hypertext, Data life cycle, Database Technology, Database Architecture, Database Management Systems and Interfaces.

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

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

REFERENCE BOOKS:
2. “Bioinformatics” AttWood, pearson education, 2004
UNIT-I: Analog and digital circuit design of circuits for biomedical applications using operational amplifiers, data acquisition, conversion, and interface to microcomputers. Patient safety, patient isolation circuits. Operating principles of various types of patient isolation circuitry. Most suitable isolation circuit for a given application. Test isolation circuits.

UNIT-II: Data acquisition, Sample and Hold Conversion, Multi Channel acquisition, High speed sampling in ADC, Selection of drive amplifier for ADC performance, Gain setting and level shifting, ADC input protection, Multichannel channel applications for data acquisition systems, External protection of amplifiers, High speed ADC architectures.

UNIT-III: Interference and noise reduction techniques. Types of noise-Thermal noise, shot noise, excess noise, Burst, Internal noise in OPAMPs, Noise issues in high speed applications, Causes of noise and interference encountered in medical equipment. Manifestation of noise or interference. Techniques for minimizing the impact of noise or interference when using various types of medical equipment.

UNIT-IV: Hardware approach to digital signal processing, Coherent and non-coherent sampling, Digital signal processing techniques, DSP hardware, ALU, Multipliers, accumulators, data address generators, serial ports, system interfacing ADC’s and DAC’s to DSPs. Interfacing IO ports to DSPs.


TEXTBOOKS:

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

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

UNIT III

UNIT IV
Pacemakers & Defibrillator: Need for cardiac pacemaker, external pacemaker, implantable pacemakers-types, ventricular synchronous demand pacemaker, programmable pacemaker, power sources for implantable pacemakers. Need for defibrillator, DC defibrillator, automatic external defibrillator, implantable defibrillators

UNIT V

**TEXTBOOK:**

**REFERENCE BOOKS:**
UNIT – I
Learning and Soft Computing: Examples, basic tools of soft computing, basic mathematics of soft computing, learning and statistical approaches to regression and classification.

UNIT – II

UNIT – III
Radial Basis Function Networks: ill posed problems and regularization technique, stabilizers and basis functions, generalized radial basis function networks.

UNIT – IV

UNIT – V
Support Vector Machines: Risk minimization principles and the concept of uniform convergence, VC dimension, structural risk minimization, support vector machine algorithms.

TEXT BOOKS:
1. Artificial Neural Network, Dr.B. Yegnanarayana, Pearson Edu in, PHI, New Delhi, 1999.
2. Introduction to Artificial Neural system, J.M.Zurada, Jaico Publications, 1994
3. Bart Kosko, “Neural Networks and Fuzzy Systems” prentice Hall of India, 2005

REFERENCE BOOKS:
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech (BMSP & I)  
I SEMESTER

BIOSTATISTICS  
(ELECTIVE-II)

UNIT- I
Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, properties of probability, probability distributions, sampling distributions.

UNIT- II
Estimation and hypothesis testing. Confidence intervals for data, t distribution, determination of sample size for estimating means and proportions. Hypothesis testing for a single population mean/proportion difference between two population means/proportions, sample size to control type I and type II errors.

UNIT- III
Analysis of variance. The completely randomized design, random sized complete block design, repeated measures design.

UNIT- IV
Regression and correlation. Simple linear regression model, regression equation, the correlation model, multiple linear regression model, multiple regression equation, multiple correlation model, additional techniques of regression analysis.

UNIT- V
Chi-square distribution, tests of good fit, independence, homogeneity, non-parametric statistical procedures, regression analysis.

TEXTBOOK:

REFERENCE:
LIST OF EXPERIMENTS

Biomedical Instrumentation

1. Design of ECG Amplifier using Instrumentation Amplifier
2. ECG Recording and Heart rate measurement
3. Study of Electrical activities of Skeletal Muscles
4. Respiration Rate Measurement.
5. Demonstration of Defibrillator, Pacemaker, Heart lung machine, Hemodialysis and Short wave Diathermy.

Virtual Instrumentation

1. Design of decimal counter and function generator
2. Design of filters using NIELVIS
3. Signal processing with speed 33 (Speech recording and analysis)
4. Image processing application with vision assistant
5. Profiling VI Execution time and memory usage
8. Comparison of FIR and IIR filters.
9. Non linear filter
10. Selection and design of a digital filter design.
UNIT-I Fundamentals of Discrete-Time signals and systems:

UNIT-II The Electroencephalogram(EEG):

UNIT-III Wavelets:

UNIT-IV The Electromyogram (EMG):
The electrical Activity of Muscles, Amplitude Estimation in the surface EMG, Spectral Analysis of the surface EMG, Conduction velocity Estimation, Modeling the EMG, EMG Signal Decomposition

UNIT-V The Electrocardiogram(ECG):
Heart Rhythms, Heart beat Morphologies, Noise and Artifacts, Baseline Wander, Power line interference, Muscle Noise Filtering, QRS Detection, Wave Delineation, Data Compression, Heart Rate Variability, Acquisition and RR Interval conditioning , Spectral Analysis of Heart Rate Variability.

TEXTBOOKS:

REFERENCES:
2. Roberto Cristi, Modern Digital Signal Processing
UNIT-I Basic Medical Imaging Modalities:
X-ray, CT, Ultrasound, MRI, PET-CT, SPECT-CT, Gamma Camera, Catheterization Lab. Aspects of light imaging, convolutions and transforms, photometry lenses and depth of field, Image perception and 3D Imaging, Image acquisition, Display, Image processing operations, scanning & segmentation.

UNIT-II Computed Tomography:
Basic concepts of CT, Non Spiral CT technology, Concepts of Spiral CT Scanner, Multi Slice spiral technology, Various Peripheral devices. Applications: Multiplanar Reconstruction, Maximum Intensity Projection, 3D, CT Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Cardiac CT (Calcium scoring, Coronary Angiography, Lesion Quantification).


UNIT-IV Magnetic Resonance Imaging:
Permanent & Super conducting magnets, Signal generation and detection, signal characteristics, signal localization, Fourier transforms in MRI, Imaging Reconstruction. Image artifacts. Coil technology, Parallel acquisition techniques, Various peripheral devices. Applications: Functional Imaging, Perfusion & Diffusion imaging (Echo planar imaging), Multi direction diffusion tensor imaging, Single & Multi Voxel Spectroscopy, MR Angiography, MRCP, Cardiac MRI (Myocardium viability, Valve function etc.), Flow Quantification.

UNIT-V Gamma Camera:
Physics of Gamma camera, basic Instrumentation, Imaging techniques, SPECT & Whole Body studies. Applications of Gamma camera in Cardiology, Nephrology, Neurology etc., PET: Fundamentals of PET scanner & PET-CT, Crystal technology, Cyclotron principle, Hot Lab equipments. Applications of PET: Cardiology, Neurology & Cardiology.
TEXTBOOKS:

REFERENCES:
Unit -I:
Optical fibers and their properties

Unit-II:
Laser Fundamentals

Unit-III:
Industrial Applications of Optical fibers and Lasers

Unit-IV: Holography
Holography – Basic principle; methods, Holographic Components, Holographic Interferometry and Applications, Holography for Non-destructive Testing

Opto-Electronic Components
Magneto Optic and Acoustic – optic and other types of Optical Modulators – Detectors – Application in Instrumentation

Unit-V: Medical Applications of Laser

TEXT BOOKS:
1. Leon Goldman "The Biomedical laser technology and clinical Applications', Springer Verlag,1981
REFERENCES:
5. Laser Electronics by Verdeyn JT, Prentice Hall.
UNIT –I:

Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

UNIT –II:
Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation UNIT, Programmability and Program Execution, Speed Issues, Features for External interfacing.

UNIT –III:
Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX Processors.

UNIT –IV:
Introduction to Blackfin Processor - The Blackfin Processor, Introduction to Micro Signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

UNIT –V:
Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

TEXT BOOKS:
REFERENCE BOOKS:
4. Digital Signal Processing Applications Using the ADSP-2100 Family by The Applications Engineering Staff of Analog Devices, DSP Division, Edited by Amy Mar, PHI
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech (BMSP & I) II SEMESTER

ADAPTIVE SIGNAL PROCESSING
(ELECTIVE-III)

UNIT –I:

UNIT –II:
Searching the performance surface – Methods & Ideas of Gradient Search methods - Gradient Searching Algorithm & its Solution - Stability & Rate of convergence - Learning Curves.

UNIT –III:

UNIT –IV:

UNIT –V:

TEXT BOOKS:

REFERENCE BOOKS:
UNIT -I:
Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization

UNIT –II:

UNIT -III:
Radiation Sensors: Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors

UNIT -IV:
UNIT -V:


**TEXT BOOKS:**

**REFERENCE BOOKS:**
Unit-I: CLASSIFICATION OF INSTRUMENT TRANSDUCERS

UNIT-II: SIGNAL CONDITIONING FOR RESISTIVE SENSORS: measurement of resistance, voltage dividers, Wheatstone bridge. Balance and deflection measurements, sensor bridge calibration and compensation instrumentation amplifiers, interference types and reduction

UNIT-III: SIGNAL CONDITIONING FOR REACTANCE VARIATION SENSORS: problems and alternatives, ac bridges, carrier amplifiers - application to the LVDT, variable oscillators, resolver-to-digital and digital-to-resolver converters

UNIT-IV: SIGNAL CONDITIONING FOR SELF-GENERATING SENSORS: chopper and low-drift amplifiers, offset and drifts, amplifiers- electrometer amplifiers, charge amplifiers, noise in amplifiers

UNIT-V: DIGITAL SENSORS: position encoders, variable frequency sensors - quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, charge-coupled sensors - types of CCD imaging sensors, ultrasonic based sensors, fiber-optic sensors

TEXT BOOKS:

REFERENCES:
UNIT I MEMS AND MICROSYSTEMS
Mems and Microsystems-General principles, advantages, materials used- properties, Technology involved in MEMS. Fabrication techniques- Lithography- etching- Ion implantation- wafer bonding. Integrated processing- Bulk Micro machining- Surface micro machining- coating technology and CVD- LIGA process.

UNIT II MICROSENSORS AND MICROACTUATORS
Microsensors and Microactuators-working principle, types- pressure sensors, thermal sensors and actuators, piezoelectric crystals-Intelligent materials and structures, Magnetic sensors and actuators- magnetic materials used for MEMS.

UNIT III MEMS AND MICROFLUIDIC SYSTEM

UNIT IV INTRODUCTION TO NANOTECHNOLOGY
Essence of Nanotech, Nanofying electronics, Properties of nanomaterials, metal nano clusters, semiconductor nano particles, nano composites. Introduction to carbon nano structure, carbon molecules, carbon clusters, nanotubes application.

UNIT V MEDICAL APPLICATIONS OF NANOTECHNOLOGY
Nanotechnology and Biomedicine-Drug synthesis and delivery – Nanobiomedicine and diagnostic-nano fabrication methods-nanomaterials in human body- toxicity in nanomaterials.

TEXT BOOKS:

REFERENCE BOOKS:
UNIT –I:  

UNIT –II:  
**Time Domain Models for Speech Processing:** Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

UNIT –III:  

UNIT –IV:  

UNIT-V:  
**Automatic Speech & Speaker Recognition:** Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System

**Hidden Markov Model (HMM) for Speech:** Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMS,

**Speaker Recognition:** Recognition techniques, Features that distinguish speakers, Speaker Recognition Systems: Speaker Verification System, Speaker Identification System.
TEXT BOOKS:

REFERENCE BOOKS:


TEXT BOOKS:
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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech (BMSP & I) II SEMESTER

ADVANCED MEDICAL SIGNAL & IMAGE PROCESSING LAB

LIST OF EXPERIMENTS

NOTE:
• Minimum of 10 Experiments have to be conducted.
• All Simulations are to be carried out using MATLAB/DSP PROCESSORS/LAB VIEW SOFTWARE & DSP KITS.

MEDICAL SIGNAL PROCESSING

a. Least Squares, Orthogonality, and Fourier series
b. Correlation, Fourier Spectra and the Sampling Theorem
c. Linear systems and Transfer Function
d. FIR Filter Design for Biomedical signal processing
e. IIR Filter Design for Biomedical signal processing
f. ECG noise cancellation
g. Biomedical Signal Compression

MEDICAL IMAGE PROCESSING

a. Study of Basic commands in MATLAB
b. Image Linear Filtering and Transforms
c. Image Segmentation
d. Image Restoration techniques
e. Image registration
f. Image Analysis
g. Enhancement and restoration
h. Morphological Operation