SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF ENGINEERING &TECHNOLOGY

STRUCTURE OF T.E (Part I) W.E.F 2016-17

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering &Technology (Revised from 2014-2015)

Credit System Structure of T.E. Biomedical Engineering W.E.F 2016-17

Semester – I

Subject	Hrs/Week			Credits	Examination Scheme			
	L	T	P		ISE	ESE	ICA	Total
Bio Medical Instrumentation -I	4	-	-	4	30	70	-	100
Biological Modeling & Simulation	4	-	-	4	30	70	-	100
Microprocessors & Microcontroller	4	-	-	4	30	70	-	100
Principals Of Communication	4	-	-	4	30	70	-	100
Signals &System	4	-	-	4	30	70	-	100
Sub Total	20	-	-	20	150	350	-	500
Laboratory								
						ESE			
						POE	OE		
Bio Medical Instrumentation -I	-	-	2	1	-	50	-	25	75
Biological Modeling & Simulation	-	-	2	1	-	-	25	25	50
Microprocessors & Microcontroller	-	-	2	1	-	50	-	25	75
Principals Of Communication	-	-	2	1	-	-	-	25	25
Signals &System	-	-	2	1	-	-	-	25	25
Hospital Training	-	-	-	-	-	-	-	50	50
Sub Total	-	-	10	5	-	125		175	300
Grand Total	20	-	10	25	150	475		175	800

Note: Abbreviations: L-Lectures, P-Practical, T-Tutorial, ISE-In Semester Exam, ESE-End Semester Exam, ICA-Internal Continuous Assessment, ESE- University Examination (Theory &/ POE &/Oral Examination)

Note: Hospital training min of one week and submitting of report carry TW of 50 marks

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Credit System Structure of T.E. Biomedical Engineering W.E.F 2016-17 Semester –II

Subject	Hrs/Week			Credits	Examination Scheme			
	L	T	P		ISE	ESE	ICA	Total
Biomedical Instrumentation -II	4	-	-	4	30	70	-	100
Digital Signal Processing	4	-	-	4	30	70	-	100
Medical Imaging -I	3	-	-	3	30	70	-	100
Control System	4	-	-	4	30	70	25	125
Embedded system	4	-	-	4	30	70	-	100
Sub Total	19	-		19	150	350	25	525
Laboratory								
						ESE		
						POE	OE	
Biomedical Instrumentation -II	-	-	2	1	-	50	-	25	75
Digital Signal Processing	-	-	2	1	-	-	-	25	25
Embedded system	-	-	2	1	-	50	-	25	75
Medical Imaging -I	1	-	-	1	-	-	25	25	50
Mini Project	-	2	2	3	-	-	25	25	50
Sub Total	1	2	8	7	-	150		125	275
Grand Total	20	02	08	26	150	500		150	800

Note: Abbreviations: L-Lectures, P-Practical, T-Tutorial, ISE-In Semester Exam, ESE-End Semester Exam, ICA-Internal Continuous Assessment, ESE- University Examination (Theory &/ POE &/Oral Examination)

T.E. (Bio – Medical Engineering) Part I

Biomedical Instrumentation - I

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hr/week	Theory: 100 Marks
Practical: 2 hr/week	Term Work: 25 Marks
	POE: 50 Marks

CourseObjectives

1. The objective of this course is to introduce students to the of various biomedical diagnostic and theraptic instruments .It includes basic principles, constructions, working, technical specifications of various biomedical sensors, transducers and instrumentation and respective medical applications.
2. This course contents various pathological i.e. blood testing equipments, life supportive equipments and audiometers.

CourseOutcome

By the end of this course the students will be able to:

1. Classify different biomedical sensors and transducers along with their principles, constructions and workings
2. Also they will learn physical and technical specifications of various biomedical diagnostic and therapticequipments with their applications

Section I

UNIT 1. Introduction of Biomedical Instruments

Basic principle, technical specification, working and applications of Analytical and Laboratory Instruments **(14 Hrs)**

1. Spectrophotometer
2. Colorimeter
3. pH meter.
4. Centrifuge
5. Electrolyte Analyzer
6. Blood cell counter
7. Electrophoresis
8. Chromatography and mass spectroscopy
9 Microscopes
10. ELISA reader & WASH

UNIT 2. Blood Gas Analyzer **(05 Hrs)**

Measurements of Blood pH, pCo2 pO2 and complete Blood Gas analyzer.

UNIT 3. Blood Flow Measurement **(08 Hrs)**

Electromagnetic, Ultrasonic, NMR and Laser Doppler flow metry, cardiac output measurement, impedance plethysmography

Section II

UNIT 4. **Pulmonary Function Analyser and Ventilator** **(12 Hrs)**

Respiration measurement technique: Lung volume and capacities. Spirometry, Pulmonary function measurement and analyzer, spirometer and respiratory function analyzer.Oximetry, Ventilators Respiratory Therapy Equipment and Anesthesia Equipment

UNIT 5. **Heart Lung machine:** **(04 Hrs)**

Working Principle, block diagram, functions, specifications, different parts

UNIT 6. Audiometers **(05 Hrs)**

Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry

Term work:

Term work will consist of at least Eight Laboratory Experiments/Demonstrations based on the above syllabus. Test and Assignments/Seminars be suitably graded by teachers and attached in the journal.

Text Books:

1. Handbook of Biomedical Engineering By R.S. Khandpur (TMH Pub).
2. Handbook of Analytical Instruments By R.S. Khandpur (TMH Pub).
3. Medical Instrumentation, Application and Design By J.G. Webster.
4. Medical Electronics – A.G. Patil ,R K Jha, R Hariharan(Excel Books, New Delhi)

References:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson Education Pub)
3. Introduction to Biomedical Engineering – Joseph Bronzino (CRC Press)
4. Various Instruments Manuals.

T.E. (Bio-Medical Engineering) Part-I

Biological Modeling and Simulation

Teaching Scheme:
Lectures: 4 hr/week
Practical: 2 hr/week
OE: 25 Marks

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

CourseObjectives

The objective of this course is to develop and design different human biology and physiology system's models which includes neuromuscular functions, eye movements, thermoregulatory, immune and insulin glucose systems of human body. These models are based upon experimented data and it is analyzed by testing it using various software simulations.

CourseOutcome

With the study of this course students will be able to:

1. Learn different statically, mathematical models of human body system which are based on performed experiments. Also they will learn to test these results by using HHSIM and MATHLAB simulation software.
2. They will be able to design and formulate new human body system models with their validation and applications.

Section I

UNIT 1. Physiological Modeling: **(9 Hrs)**

Steps in Modeling, Purpose of Modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system, regulation of cardiac output and respiratory system.

UNIT 2. Model of Neurons: **(13 Hrs)**

Biophysics tools, Nernst Equation, Donnan Equilibrium, Active Transport (Pump) GHK equation, Action Potential, Voltage Clamp, Channel Characteristics, Hodgkin- Huxley Conductance Equations, Simulation of action potential, Electrical Equivalent model of a biological membrane, impulse propagation- core conductor model , cable equations.

Section II

UNIT 3. Neuromuscular System: **(06 Hrs)**

Modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.

UNIT 4. Eye Movement Model: (06 Hrs)

Four eye movements, quantitative eye movement models, validity criteria.

UNIT 5. Thermo regulatory systems: (04 Hrs)

Thermoregulatory mechanisms, model of thermoregulatory plant system, controller model, validation and application.

UNIT 6. Modeling the immune response: (06 Hrs)

Behavior of the immune system, linearized model of the immune response., Pharmacokinetics Drug delivery, Modeling of Insulin Glucose feedback system

Term Work –

List of Experiments/Assignments:

1. Simulations of Nernst equation using HHSIM.
2. Simulations Donnan equation using HHSIM.
3. To Study the effect of different drugs on nerve action potential curves using HHSIM.
4. To study the effect of different stimulus on action potential curves using HHSIM.
5. To design muscular stretch reflex model using MATLAB simulation.
6. To simulate Hodgkin's Huxley model using HHSIM.
7. Developing a model of neuron using NEURON1.1 software**.**
8. Study of Na conductance and K conduction currents on voltage clamp mechanism using HHSIM.

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.:A.TeriBahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

T.E. (Bio – Medical Engineering) Part I

Microprocessors and Peripherals

Teaching Scheme:
Lectures: 4hr/week
Practical: 2 hr/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks
POE: 50 marks

CourseObjectives

1)To develop an in-depth understanding of the operation of microprocessors and Microcontrollers, machine language programming & interfacing techniques.

CourseOutcome

1) The student will learn the internal organization of some popular microprocessors/microcontrollers.
2)The student will learn hardware and software interaction and integration
3) The students will learn the design of microprocessors/microcontrollers-based systems.

Section I

UNIT- 1.
Semiconductor Memories (5)
Memory Classification- RAM, ROM, PROM, EPROM, EEPROM, memory organization, memory expansion, EPROM Programming Methods.

UNIT- 2.
Fundamentals of Microprocessors:-
INTEL 8085A- Features, Functional Pin Configuration, Architecture,Demultiplexing of address & data bus, Generating different control signals, Instruction Set-Addressing Modes, Classification, timing diagrams, Programming with Assembly language, single stepping, single cycle execution, Transition states diagram-HOLD, WAIT,RESET & HALT.
(10)

UNIT- 3.
Interrupts:
Basic concepts, Classification-Hardware & Software Interrupts , Interrupt Structure of 8085,Instructions related to interrupts, Programming using Interrupts (5)

SECTION –II

UNIT- 4.
Basics of I/O Interfacing
Concepts of I/O Ports, Data transfer techniques, Memory mapped I/O & I/O Mapped I/O Schemes. **(5)**

UNIT- 5.
Introduction to Microcontroller MCS 51 family:
Compare microprocessor & microcontroller, Architecture of 8051, Memory organization, Functional pin description, SFRs and various resources of MCS 51.
Addressing modes, Instruction set and Assembly language programming of 8051 (5)

UNIT- 6.

Interfacing and Hardware overview: study of Port structure, interrupt structure, Timers, Serial port Interfacing of Switches, LED, Relay, Buzzer, LCD display, Matrix keyboard, ADC 0809, DAC 0808 with MCS 51 microcontroller (12)

Text Books:

1. Microprocessor Architecture, Programming and Applications with 8085A-Ramesh Gaonkar-Wiley Eastern Ltd.New Delhi.
2. Microprocessors and Programming Logic-Kenneth L.Short-2nd Edition,Pearson Education
3. INTEL- Microprocessor Peripheral hand book, application notes, Manual
4. Fundamentals of Microprocessor and Microcomputer –B Ram-DhanpatRai Publication
5. Microprocessor and Peripherals-S.P.Choudhary,SunitaChoudhary-Scitech Publication
6. Microprocessor Architecture, Programming and System featuring 8085-William A.Raut-Cengage Learning Publication

Term Work: List of Experiments:(minimum 10 experiments)

1. Programs based on different addressing modes, arithmetic and logical instructions.
2. Multiplication of two 8-bit numbers using the method of successive addition and shift and add.
3. Division of two 8-bit numbers using the method of successive subtraction
4. Block transfer and block exchange of data bytes.
5. Finding the smallest and the largest element in a block of data.
6. Arranging the elements of a block of data in ascending and descending order.
7. Converting two digit numbers to their equivalents
   a) BCD to HEX
   b) HEX to BCD
8. Generating delays of different time intervals using delay subroutines and measurement of delay period on CRO using SOD pin of 8085A.
9. A) Separation of single byte from a word.
   B) Addition of these separated bytes and storing the sum at next consecutive ML.
   C) Reversing the upper byte and lower byte of given number.
10. A) 16 bit sum of string of data.
    B) Reversing a string of data.

A) Hardware based (Minimum 6 experiments)

1. Program control data transfer using 8255 PPI
   A) To INPUT data bytes from peripheral port and to store them in memory
   B) To OUTPUT data bytes from memory to peripheral port
2. Study of interrupts by enabling them in main line program and then executing different subroutines when TRAP, RST7.5, RST 6.5 & RST 5.5 are activated
3. Interfacing 7 segment LED display using 8255A- in static & dynamic mode
4. Interfacing ADC0809
5. Interfacing DAC0808
6. Interfacing Stepper motor with MPU using 8255A- in half and full excitation
7. Interfacing of 8253/8254
8. Interfacing of 8251

T.E. (Bio – Medical Engineering) Part I

Principles of Communication

Teaching Scheme:
Lectures: 4 hr/week
Practical: 2 hr/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

CourseObjectives

1)To provide basic knowledge of wired and wireless communication which will help the students to pursue higher studies or employment in core companies related to telecom sector

2) To develop students with solid foundation in mathematical, engineering fundamentals to solve communication engineering problems.

3) To provide students rigorous training to design and develop electronic systems, such as AM, FM transmitter used in real life.

4) To provide a platform to the students to get them acquainted with issues related to emerging technologies in communication engineering and their impact on global economy.

CourseOutcome

1) Learner will apply knowledge of mathematics to solve numerical based on amplitude modulation and frequency modulation to calculate bandwidth requirement and transmitter power.

2)Students will understand various modulation techniques and would be able to generate IC based AM, FM signal.

3) Learner will understand various demodulation techniques and will recover original information signal.

4) Learner would also be capable to identify various modulation and demodulation techniques and able to solve communication engineering problems theoretically and practically.

5) Learner will be capable to calculate bandwidth for AM, FM transmitter using modern instruments like digital storage oscilloscope (DSO).

Section I

UNIT- 1.Introduction(6 Hrs)

Block schematic of communication system, base band signals, RF bands, Necessity of modulation, types of modulation – AM, FM, PM and Pulse Modulation. Noise types, Noise figure. Introduction to radio wave propagation, ground wave, space wave and sky wave.

UNIT- 2. Amplitude Modulation(8 Hrs)

Amplitude Modulation principles, AM envelope, frequency spectrum & BW, phase representation of AM wave, Modulation index, % modulation (Numerical expected)AM transmitters: Block of low level DSBFC, High level DSBFC, Trapezoidal patterns Evolution and descriptions of SSB, Suppression of carrier using balanced modulator, Suppression of unwanted sideband, Methods: Filter system, phase shift & third method vestigial sideband (VSB)

UNIT- 3. Angle Modulation(8 Hrs)

Theory of frequency and phase modulation, mathematical analysis, deviation sensitivity, FM and PM waveforms, phase deviation and modulation index, frequency deviation and percentage modulation, angle modulation circuits using varactor diode ,using frequency analysis of angle modulated wave-Bessel function, BW requirements, deviation ratio, Noise and angle modulation, pre-emphasis and de-emphasis.

Section II

UNIT- 4. Pulse Modulation(08 Hrs)

Pulse amplitude modulation, Sampling theorem & type: Natural & flat top, PAM modulation circuit, PAM demodulation circuit, TDM and FDM, Crosstalk in TDM, pulse time modulation, generation of PTM signals (direct-indirect method), PWM modulator, PPM modulators, demodulation of PTM.

UNIT- 5. Digital Modulation Techniques and data formats (08 Hrs)

Unipolar, Bipolar, RZ, NRZ, Transmission modes ASK, FSK, PSK - coherent, Non- coherent, BPSK, DPSK, QAM. Comparison

UNIT- 6. Coding (08 Hrs)

1. Source coding- Quantization types -Uniform, Non- Uniform, PCM, DPCM, ADPCM, DM, ADM.
2.Channel Coding -Types of Errors & codes, linear block codes, error detection & correction, Hamming codes, Look-up table decoding, Binary Cyclic codes, Convolution codes, Encoders, Decoders, Code tree.

Experiment List : (Minimum 10 Experiments)

1) Amplitude Modulation
2) Frequency Modulation
3) Pulse Amplitude Modulation
4) Pulse width Modulation
5) Pulse position Modulation
6) Pulse Amplitude Modulation - TDM
7) PCM-TDM
8) Study of Compander
9) Study of DPCM.
10) Study of ADPCM.
11) Study of DM.
12) Study of CVSD.
13) FSK (freq. Shift keying)
14) PSK (Phase Shift keying)
15) Study of data format

Text Books:

1) Communication System, Analog and Digital
R.P. Singh and S.D. Sapre (THM)
2) Electronic Telecommunication System (4th Edition)
George Kennedy and Bernard Devise (MGH)
3) Louis E. Frenzel ‘Principles of Electronic Communication System’-
IIIrd edition - Tata McGraw Hill Publication
4) K. Sam Shanmugam – Digital & Analog Communication (John Wiley)

Reference Books:

1. Introduction to Analog and Digital Communication
Simon Haykin
2. Principle of Digital Communication
Das, Mullik, Chattergy
3. Digital Communication
SirnonHaykin
4. Principles of communication
Taub& Schilling (MGH)
5. Digital Communication
Ch.kranthiRekha (Scitech)

T.E. (Bio-Medical Engineering) Part-I

Signals and Systems

Teaching Scheme:
Lectures: 3 hr/week
Tutorial :1 hrs/week
Practical: 2 hsr/week

Examination Scheme:
Theory: 100 Marks
Term Work : 25 Marks

CourseObjectives

1)Learn the use of random-process (or stochastic-process) models to represent non-deterministic signals and noise, and extract from these models the time-domain and frequency-domain structure of the signals and noise;
2)Analyze the response of linear, time-invariant dynamic systems to random input signals or noise, and understand how the resulting outputs reflect input and system characteristics;
3) Use probabilistic characterizations of random signals and noise, and measurements derived from these signals, to make optimal inferences about related signals and systems;
4)Understand the notion of state for a causal system, the relation of state to system input and output signals, and the use of state in inference and feedback control for the system;

CourseOutcome

1)Compute and interpret means, correlations/covariance of random variables;
2)Compute and interpret auto- and cross-correlation/covariance functions of random processes;
3) Formulate and solve minimum conditional-expected-cost inference problems, particularly for
   a. square-error costs, leading
   b. all-or-none costs, leading
4) identify appropriate state variables in particular problems, write corresponding state-space equations, compute equilibrium solutions, obtain linearized state-space models describing small deviations from equilibrium;
5) analyze systems for
a. discrete-time (DT) processing of continuous-time (CT) signals;
b. DT control of CT systems via sampled-data control;
c. CT communication of DT signals via pulse-amplitude modulation (PAM), pulse shaping and filtering to combat channel distortions (frequency-dependent group delay and amplitude response, noise).

Section I

UNIT- 1. Introduction to signals: (06)

Definition of signals, classification of signals: continuous time signals & discrete time signals, operation on signals, properties of signals -even & odd signals, periodic & aperiodic, deterministic & non-deterministic, energy and power, deterministic signals: unit impulse, unit step, unit ramp, exponential & sinusoidal, Singularity function.

UNIT- 2. Linear time- invariant systems: (08)

Representation of signals in term of impulses, classifications of systems-linear and nonlinear systems, time variant and time invariant systems, stable and unstable systems, Static and Dynamic systems, Causality, continuous time-LTI systems, The convolution integral, discrete

time LTI systems, the convolution sum, Systems described by differential, difference equations, block diagram representation of LTI systems.

UNIT- 3. Sampling: (04)

Representation of continuous time signals by its samples, the sampling theorem in time and frequency domain, Reconstruction of signals from its samples using interpolation, The effect of under sampling, aliasing, Discrete time processing of continuous time signals.

Section II

UNIT- 4. Fourier analysis for Continuous Time & Discrete Time: (08)

Continuous time & discrete time Fourier series: Trigonometric and Exponential Fourier series and Derivation, properties of Fourier series: linearity, time shifting, frequency shifting, time reversal, time scaling, time differentiation & time integration, multiplication, convolution.

UNIT- 5. Fourier Transform: (06)

Concept of Fourier transform on functions: rectangular, impulse, signum. Properties of Fourier transform: linearity, time shifting, frequency scaling, time scaling, multiplication, and Convolution.

UNIT- 6. Z transform: (04)

Introduction , need of Z-transform, ROC, properties of ROC, Unilateral Z-transform, properties of Z Transform: linearity, time shifting, time reversal, time scaling, convolution, differentiation, Multiplication, Parsevals theorem,. Inverse Z-transform: PFE Method, long division method, residue method, convolution method. Transfer function (Poles & Zeros), stability and causality of system in Z transform

- **Text Books:**

1.RameshBabu ‘Signals & system’, SciTech Publication.

2.Salivahanan, Vallavaraj, Gnananapriya ‘Digital Signal Processing’, TMH

- **Reference Books :**

1. Simon Haykin, Barry Van Veen- ‘Signals & system’ - IInd Edition Wiley publication
2. Michael J. Roberts. -‘Fundamentals of signals & systems’- Tata McGraw Hill, 2007.
3. Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab -‘Signals & system’ -IInd Edition - Pearson Education.
4. H.A HSU, ‘Signals & system’ (Schaum’s out lines), Tata McGraw Hill
5. SmarajitGhosh, ‘Signals & system’ Pearson Education.
6. Charles L. Philips, John M. Parr, Eve A. Rislein ‘Signals, system & transform’, III Edition, Pearson Education.
7.. Benoit Boulet ‘Fundamentals of signals & System’ Thomsan Learning

- **Term work**

Term work shall consist of Minimum 08 Tutorials and 08 experiments

- **List of Experiments :**

1. Generation of CT signals
2. Generation of DT signals
3. Even and odd components of a given signal
4. Convolution of sequences
5. Converting CT Signal to DT using sampling theorem
6. Effect of under sampling and over sampling
7. Reconstruction
8. Fourier transform
9. Z-transform
10. Inverse Z-transform

T.E. (Bio – Medical Engineering) Part II

Biomedical Instrumentation-II

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hr/week	Theory: 100 Marks
Practical: 2 hr/week	Term Work: 25 Marks
	POE: 50 Marks

CourseObjectives

Objective of this course is to study generation of human body's cell potential, their recording techniques and medical application. This course includes different diagnostic and therapticequipments along with their principles, types, workings, designing, technical specifications .

Course Outcomes

After studying this course students will able to design various biomedical instruments that includes signal recording machines, monitoring equipments, telemetry and their respective medical application. Also students will learn safety precautions and hazards of biomedical equipments.

Section I

UNIT- 1. Generation of Bioelectric Potentials (5 Hrs)

Nerve, Muscle, Pacemaker and Cardiac muscle

UNIT- 2. Biophysical signal capture, processing and recording systems (with technical specifications) (10Hrs)

Typical medical recording system and general design consideration.Sources of noise in low level recording circuits. ECG, EMG, EEG, EOG, ERG. Phonocardiography.Measurement of skin resistance.

UNIT-3.Patient Monitoring System (08 Hrs)

Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea Detector.

Section II

UNIT-4.Arrhythmia and Ambulatory Monitoring Instruments (06 Hrs)

Cardiac Arrhythmias.Ambulatory monitoring instruments.

UNIT-5.Foetal and Neonatal Monitoring System:(06 Hrs)

Cardiotocograph , Methods of monitoring of Foetal Heart rate and labor activity, Foetal scalp PH measurement, Incubator and Infant warmer.

UNIT-6. **Biotelemetry, Telemedicine concepts and its application** **(06 Hrs)**
Working principle, block diagram & medical applications

UNIT-7. Biofeedback Technique: EEG, EMG **(04 Hrs)**
Working principle, block diagram, clinical analysis & diagnosis

UNIT-8. Electrical Safety in Biophysical Measurements **(02 Hrs)**
Safety hazards, leakage current, protection & precautions

Term work:
Term work will consist of at least 08 Laboratory Experiments based on the above syllabus. Test and Assignments/Seminars be suitably graded by teachers and attached in the journal.

List of practicals:

1. To design of notch filter using IC-741

2. To designing low pass filter using IC-741.

3. To design instrumentation amplifier using IC-741.

4. To design stable positive power supply using IC-741.

5. To design peak detector using OPAMP.

6. To design square wave generator using IC-555 timer.

7. To design voltage regulator using LM-317.

8. Study experiment on available kits.

Text Books:

1. Handbook of Biomedical Engineering By R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design By J.G. Webster, TMH.
3. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson
4. Education Pub)
5. Introduction to Biomedical engineering by J Bronzino

References Books:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2.Various Instruments Manuals.
3. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley inter science publication.
4 Principles of Biomedical Instrumentation and Measurement by Richard Aston

T.E. (Bio – Medical Engineering) Part II
Digital Signal Processing

Teaching Scheme:
Lectures: 4 hr/week
Practical: 2 hr/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

CourseObjectives

1)To be able to explain and apply sampling theory, analog to digital conversion, digital to analog conversion and to understand ideal and non-ideal sampling and reconstruction.[a,c,e]
2) To introduce the student to the tools and mathematical techniques necessary for understanding and analyzing both continuous-time and discrete-time systems. [a,k]
3) To describe and design lowpass, highpass, or bandpass FIR and IIR filters to meet specific design specifications. [a,c,e,k]

CourseOutcome

1) The student will be able to explain and apply sampling theory, analog to digital conversion, digital to analog conversion and understand ideal and non-ideal sampling and reconstruction. [A,B,]

2) The student will be able to design DSP systems for processing continuous-time signals, transfer continuous-time specifications to discrete-time implementation and understand the definition, properties and applications of the Discrete Fourier Transform.

3) The student will be able to design low pass, high pass or band pass FIR filters to meet frequency domain specifications using windowing methods. [C]
4) The student will be able to implement complex arithmetic functions using MATLAB functions in the analysis of FIR and IIR filtering. [C]

Section I

UNIT- 1. The Discrete Fourier Transform **(**10)

Frequency domain sampling ,Reconstruction of Discrete time signals, Discrete Fourier Transform(DFT), DFT as a linear Transformation, Relation between DFT & Z Transform, Properties of DFT, Circular convolution, Circular correlation, Linear Filtering methods based on DFT, Fast convolution techniques Overlap add & overlap save, Frequency analysis of signals using DFT,Discrete Cosine Transform ,Forward DCT,Inverse DCT,DCT as an Orthogonal Transform.

UNIT- 2. Fast Fourier Transform (08)

FFT Algorithm, Radix -2 Decimation in Time-DIT FFT & Decimation in Frequency-DIF FFT, IFFT, Applications of FFT Algorithms, Efficient computation of the DFT of Two Real Sequences, Efficient Computations of a 2N point Real sequence.Use of FFT in Linear Filtering and Correlation.

UNIT- 3. Realization of Digital Linear systems **(**06)

Structures for realization of Discrete time systems, Structures for FIR Filters: Direct form, Cascade form & Lattice Structure, Structures for IIR filters: Direct form, , cascade Structures, parallel form structures

Section II

UNIT- 4. FIR Filter design **(**08)

Characteristics of FIR Filter, Symmetric and Anti symmetric FIR Filters, Design of Linear Phase FIR Filter by using Windows, Frequency Sampling Method, Fourier Series Method.

UNIT- 5. IIR Filter design **(**08)

IIR Filter Design by Impulse Invariant technique, Bilinear transformation, Frequency transformations, Analog filter approximations, Implementation of IIR filters.

UNIT- 6. Adaptive Filters **(**08)

System Identification or System Modeling, Adaptive channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling, Adaptive Direct Form FIR Filters-LMS algorithm

Term work:

Term Work should consist of minimum 10 experiments based on above syllabus.

List of Experiments

Experiments may be performed using Matlab/DSP simulator/DSP Starter kit

1. Generation of DT signals
2. Convolution and correlation of signals
3. Computation of DFT & IDFT using standard formula
4. Computation of DFT using FFT algorithms
5. Computation of circular convolution
6. Design of FIR LPF, HPF, BPF, BRF filter using Fourier series method
7. Design of FIR LPF, HPF, BPF, BRF filter using frequency sampling method
8. Design of FIR filter using Window method
9. Design of IIR LPF, HPF, BPF, BRF filter using impulse invariance method
10. Design of FIR LPF, HPF, BPF, BRF filter using bilinear transformation method
11. Design IIR filter using placement of poles & zeros.
12. Computation of DCT

Text books:

1.”Biomedical digital signal processing” by Tomkins, PHI publication

2. Digital Signal Processing by S Salivahanan, AVallavaraj& C Gnanapriya -TMH

Reference Books:

1. Digital Signal Processing – Principles, Algorithms and Applications by John G Proakis- Pearson Education.

2. Digital Signal Processing – A Practical Approach by Ifeachor E.C. & Jervis B. W. -Pearson Education.

3. Fundamental of DSP using Matlab by Schilling-Cengage learning

4. Digital Signal Processing by Ramesh Babu - Scientic Publication

5. Discrete time signal Processing by A.V. Oppenheim & R.W. Schalfer.- John Wiley

6. Digital Signal Processing – A System Design approach by D.J. Defata- John Wiley

7. Digital Signal Processing Fundamentals Applications by Li Tan- Academic Press

8. Digital Signal Processing by M.H.Hayes.-(Schaums Outline) TMH

T.E. (Bio – Medical Engineering) Part II

MEDICAL IMAGING- I

Teaching Scheme:
Lectures: 3 hr/week
Tutorial: 1 hr/week

Examination Scheme:
Theory: 100 Marks
OE: 25 Marks

CourseObjectives

1) To present the fundamentals of four major medical imaging modalities, namely, X-ray including CT and digital radiography, ultrasound, endoscopy and thermography.
2) Medical imaging plays a crucial role in clinical diagnosis, treatment planning, and monitoring of treatment. It is also an important tool in many areas of medical research, including physiology, pharmacology, and neuroscience. Since Roentgen's demonstration of the image of human hand bones using his “invisible rays”, medical imaging has been at the forefront of technology, providing new tools for clinicians and medical researchers. This subject introduces imaging modalities in common clinical use, focusing on the basic principles, construction, working ,technical specifications, their respective medical applications and the process of acquisition of image data with image characteristics of each modality

CourseOutcome

With the study of this course student will be able to:

1) appreciate the role of imaging in clinical practice
2) recognize the principles, techniques, functions of different elements of the diagnostic process and the role of clinical and non-clinical personnel and agencies
3) identify principal functional components of a medical imaging devices
4) understand the processes of image acquisition
5) understand and quantify principal elements of image quality
6) recognize the effect of acquisition parameters on image quality
7) appreciate the influence of image quality on diagnostic impact and patient management
8) identify risks associated with imaging technology
9) identify advantages and limitations and applications of various modalities

Section I

UNIT- 1. Ultrasound in Medicine **(10 Hrs)**

Introduction, Production and Characteristics of Ultrasound. Display System: A-mode, B-mode and M-mode display and applications. Ultrasound transducers and instrumentation. Real-Time Ultrasound, Continuous wave and Pulsed wave Doppler Ultrasound systems, Color flow imaging, applications. Ultrasound contrast agents and applications.

UNIT- 2. X-ray Imaging **(08 Hrs)**

Properties of X-rays, Production of X-rays, X-ray interaction with Matter, Parts of X-ray machine : X-ray tubes, Rating of X-ray tubes, X-ray generators, X-ray Image and Beam Limiting Devices, Controls, X-ray Film development technique.

Section II

UNIT- 3. Fluoroscopy Imaging and X-ray Image intensifier **(03 Hrs)**

UNIT- 4. Computed Radiography and Digital Radiography **(03 Hrs)**

UNIT- 5. Angiography techniques & its applications **(02 Hrs)**

UNIT- 6.Mammography, Principle, Equipment, Digital Mammography **(03 Hrs)**

UNIT- 7. Medical Thermography: Physics of thermography, thermographic equipment, applications **(04 Hrs)**

UNIT- 8. Endoscopy: Equipment, Imaging and its applications **(03 Hrs)**

Tutorials :

Minimum eight tutorials based on above syllabus.

Text Books:

1. Christensen's Physics of Diagnostic Radiology (Lipimcott William and willkins Publication)
2. Medical Imaging Physics William R. Hendee (Wiley-Liss Publication)

References Books:

1. Biomedical Technology and Devices Handbook by James Moore
George Zouridakis (CRC Press)
2. Biomedical Engineering Handbook by Bronzino (CRC Press)
3. Physics of Diagnostic Imaging –Dowsett

T.E. (Bio – Medical Engineering) Part II

CONTROL SYSTEMS

Teaching Scheme:
Lectures: 4 hr/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

CourseObjectives

1) To teach the fundamental concepts of Control systems and mathematical modeling of the system
2) To study the concept of time response and frequency response of the system
3) To teach the basics of stability analysis of the system

CourseOutcome

1) Represent the mathematical model of a system.

2)Analyze the stability of the system

3) Determine the response of different order systems for various step inputs .

SECTION - I

UNIT 1:
Modeling of Systems: Introduction to Control Systems, Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems -Mechanical systems, Friction, Translational systems Rotational systems, Gear trains, Electrical systems, Analogous systems

UNIT 2:
Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra, Signal Flow graphs.

UNIT 3:
Time Response of feedback control systems: Standard test signals, Unit step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – state errors and error constants. Introduction to PID Controllers.

UNIT 4:
Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis; more on the Routh stability criterion.

SECTION - II

UNIT 5:
Root–Locus Techniques: Introduction, The root locus concepts, Construction of root loci.

UNIT 6:
Frequency domain analysis: Correlation between time and frequency response, Bode plots, Experimental determination of transfer functions, Assessment of relative stability using Bode Plots. Introduction to lead, lag and lead-lag compensating networks

UNIT 7:
Stability in the frequency domain: Introduction to Polar Plots, Nyquist Stability criterion, Assessment of relative stability using Nyquist criterion,

UNIT 8:
Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Solution of state equations.

TEXT BOOK :

1. **J. Nagarath and M.Gopal**, "Control Systems Engineering", New Age International (P) Limited, Publishers, Fourth edition – 2005
2. **"Principles of Control system" by S.C.Goyal&U.A.Bakshi ,Technical Publications , Pune**

REFERENCE BOOKS:

1. **"Modern Control Engineering ",** K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. **"Automatic Control Systems",** Benjamin C. Kuo and FaridGolnaagi, Wiley Studnt 8th Edition, 2009
3. **"Feedback and Control System",** Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

T.E. (Bio – Medical Engineering) Part II

Embedded Systems

Teaching Scheme:
Lectures: 4 hr/week
Practical: 2 hr/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks
POE: 50 marks

Course Objectives

1) To give opening to the field of Embedded System Design.
2) To give knowledge about the ARM core architecture.
3) To study the interfacing of input & output devices.
4) To give knowledge about the Real time operating system.

Course Outcome

1) Learn the internal organization of ARM 7 microcontrollers.
2) Learn hardware and software interaction and integration
3) Design microcontrollers-based systems.

Section - I

UNIT 1:
Embedded system Introduction:
Introduction to Embedded System, History, Design challenges, optimizing design metrics, time to market, applications of embedded systems and recent trends in embedded systems, embedded design concepts and definitions, memory management, hardware and software design and testing, communication protocols like SPI, SCI, I2C, CAN etc **(10)**

UNIT 2:
System Architecture:
Introduction to ARM core architecture,**LPC 2148,** ARM extension family, instruction set, thumb Instruction set, Pipeline, memory management, Bus architecture, study of on-chip peripherals like I / O ports, timers, counters, interrupts, on-chip ADC, DAC, RTC modules, WDT, PLL, PWM, USB etc. (**10)**

UNIT 3:
Memory Selection for Embedded System **(05)**
Memory devices, Memory selection for an embedded system, Allocation of Memory to program segments and blocks and memory map of a system, Direct Memory access, Interfacing processor, memories and I/O devices

Section II

UNIT 4:
Interfacing and Programming:
Basic embedded C programs for on-chip peripherals studied in system architecture. Need of interfacing, interfacing techniques, interfacing of different displays including Graphic LCD (320X240), interfacing of input devices including touch screen etc, interfacing of output devices like thermal printer etc., embedded communication using CAN and Ethernet, RFmodules, GSM modem for AT command study etc. (**10)**

UNIT 5:

Real Time Operating System Concept:

Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS. Introduction to Ucos II RTOS, study of kernel structure of **Ucos II,** synchronization in Ucos II, Inter-task communication in Ucos II, memory management in Ucos II, porting of RTOS. **(10)**

Reference Books:

1. Embedded Systems,Rajkamal -TMH.
2. Embedded systems software primer, David Simon - Pearson
3. ARM System-on-Chip Architecture, Steve Furber - Pearson
4. Jean J Labrose - MicroC / OS-II, Indian Low Price Edition
5. DR.K.V.K.K. Prasad - Embedded / real time system, Dreamtech
6. Iyer, Gupta - Embedded real systems Programming , TMH
7. Steve Heath - Embedded System Design ,Neuwans
8. FrankVahid - Embedded Systems , Wiley India
9. Peckol - Embedded Systems , Wiley India

List of Practical:

1) Writing basic C-programs for I / O operations
2) C-Program to explore timers / counter
3) C-programs for interrupts
4) Program to demonstrate UART operation
5) Program to demonstrate I2C Protocol.
6) Program to demonstrate CAN Protocol.
7) Program to interface LCD
8) Program to interface Keyboard and display key pressed on LCD
9) Program to interface stepper motor
10) Interfacing 4 x 4 matrix keyboards and 16 x 2 characters LCD displays to microcontroller / microprocessor and writing a program using RTOS for displaying a pressed key.
11) Writing a scheduler / working with using RTOS for 4 tasks with priority. The tasks may be keyboard, LCD, LED etc. and porting it on microcontroller/ microprocessor.
12) Implement a semaphore for any given task switching using RTOS on microcontroller board.

T.E. (Bio – Medical Engineering) Part II
Mini Project

Teaching Scheme:
Tutorial: 1 hr/week
Practical: 2 hr/week

Examination Scheme:
Term Work : 25 marks
OE: 25 marks

CourseObjectives

The mini project, done in teams of two or three, will involve the design, implementation, and evaluation of an embedded system. Projects can be hardware based, software based, or even about proving the theoretical properties of a design. A good project should address the following aspects: target applications, related existing solutions, new features and limitations of the design, technological and economic feasibility.

CourseOutcome

- Mini project should consist of Simple Bio Medical application Design, pre-testing of main blocks in the circuit on breadboard, PCB making and testing of final assembly. Mini Project based on Biomedical Modeling & Simulation & Bio Statistics is also encouraged
- **The total work should include**

1) Collection of appropriate data for main components in the project.
2) Design of circuit including analog part, digital part and suitable power supply.
3) Testing of main circuit blocks on breadboard.
4) Design of PCB layout for above designed circuit
5) Fabrication of PCB & assembly of circuit on PCB.
6) Testing and result analysis of the circuit
7) Suitable cabinet design for the circuit

- **Guidelines for project selection-**

1) Use of microcontrollers is encouraged.
2) Implementation of concepts from subjects studied is encouraged.

- **Note:**

1) A mini project group size should not exceed three students
2) Student should deliver a seminar on mini project