RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Biomedical Engineering, V-Semester

BM-5001 Biomaterials

COURSE CONTENT

Unit I

Definition and classification of biomaterials: Application of polymers, metals, ceramics and composite as biomaterials for implantation. Surface properties of materials physical properties of materials- mechanical properties- viscoelasticity.

Unit II

Structure of Solids: Crystal structure of solid – crystal imperfections – noncrystalline solid. Strength of biomaterials: Strength and strengthening mechanism of metals, ceramic, glasses and polymers. Structural properties of tissues-Bone, Teeth, Elastic tissue.

Unit III

Biocompatibility: Definition, Wound healing process- bone healing, tendon healing. Material response: Functions and Degradation of materials In-vivo. Host response: Tissue response to biomaterial, effect of wear particles. Testing of implants: Methods of test for biological performance- In-vitro implant test, In-vivo implant test methods. Qualification implant materials.

Unit IV

Metallic implant materials: Stainless Steel, Co- based alloys, Ti and Ti- based alloys. Ceramic implant materials: Alumminum oxides, Glass ceramic, Carbons. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: percutaneous and skin implants, vascular implants, heart valve implants.

Unit V

Polymeric implant materials: Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers. Rubbers, Thermoplastics. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes. Synthetic polymeric membrane and their biological applications. Biopolymers in controlled release systems. Artificial skin. Dialysis membrane.

Reference Books:

1) J B Park, "Biomaterials – Science and Engineering", Plenum Press.
2) Jonathan Black, " Biological Performance of materials", Marcel Decker
3) Piskin & A S Hoffmann, "polymeric biomaterials (EDS)", Martinus Nijhoff Publishers
4) Eugene D. Goldbera, "Biomedical Polymers", Akio Nakajima
5) A. Rembaum & M. Shen "Biomedical Polymers", Mercer Dekkar Inc.
6) Lawrence Stark & Gyan Agrawal, "Biomaterials"
7) L. Hence & E.C Ethridge, "Biomaterials – An interfacial approach.
8) Bhatt, "Biomaterials, Narosa Publication.
9) J B Park, & J D Brnzino "Biomaterials Princile & Application, CRC Press.

RAJIV GADHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Biomedical Engineering, V-Semester

BM-5002 Analog & Digital Communication

COURSE CONTENT

Unit I

Signals and its Representation

Review of Fourier transform, Convention, Signal transmission though linear systems, signal distortion in transmission, poley wiener criteria, Bandwidth and rise time, energy and power signals, spectral density and persevalls theorem for energy of power signals, Hilbert transform representation of band pass signal.

Unit II

Linear Modulation

Definition, Necessity of modulation, Principle of amplitude modulation, Generation and detection of AM, Side bands, The generation and detection of side bands, Comparison of various AM systems, FDM, Synchronous detection.

Exponential Modulation

Definitions and relationship between PM and FM frequency deviation, Bessells function, spectrum and transmission BW of FM signals, NBFM, Ves.BFM, phaser diagram of FM signal, multi tone FM, Generation and detection of FM Non linear effects in FM systems, comparison of AM and FM systems, TDM.

Unit III

Radio Transmitter and Receivers

Different types of AM and FM transmitters and receivers, AM and FM standard broadcast transmitter and receivers, image rejection, mixer.

Noise

Classification and sources of noise, Noise calculations for single and cascaded stages, SNR, SNR in DSB, SSB, VSB, AM and FM systems, pre-emphasis and De-emphasis Sampling theorem, quantization, PCM, Companding intesymbol interface, Eye patterns, Delta modulation, Adaptive delta modulation, DPCM, SIN performance of PCM and delta modulation, bandwidth of PCM and delta modulation.

Unit IV

ASK, BPSK, QPSK, M-ray PSK, DPSK, BFSK, M-ray FSK, Duo binary signaling base band signal receiver, Probability of error, Optimum filter, Matched filter, Coherent and non-coherent detection, bit error rate. Random signals, random variables and processes, cumulative distribution function, probability density function, average value, variance,

standard deviation moment and moment, generating function, characteristics function, Tchebycheffs inequality, Binary, Poisson and Gaussian distributions, other distributions, central limit theorem.

Unit V

Unit of information, average information, joint and conditional entropy, mutual information, channel capacity efficiency, BBS and BEC, Shannon's Theorem, Shannon-Hartley theorem, bandwidth - SIN ratio trade-off. Coding separable codes, Prefix property, Coding efficiency, Source coding, Shannon - Fanon code, Huffman code, Error connection codes, FEC and ARQ, Hamming distance, Minimum distance, Channel coding, Block code, Cyclic code, Convolution code.

Reference Books:

1. Communication System S Hykinl
2. Principle of Communication Taub Schilling
3. Communication System B.P. Lathi

Analog & Digital Communication

Suggested List of Experiments

1. Study of amplitude modulation and determination of modulation index. Design AM generator and its implementation
2. Design of AM detector and its implementation
3. Study of FM
4. Design of FM generator and its implementation
5. Study of waveform synthesizer
6. Verification of sampling theorem
7. Time division multiplexing
8. Study of PCM system-
9. Study of DM system
10. Study of ASK system
11. Study of BPSK system
12. Study of DPSK system
13. Study of BFSK system

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Biomedical Engineering, V-Semester

BM-5003 Advanced Microprocessors

Unit - I

Introduction to ARM processors and its versions, ARM7, ARM9 & ARM11 features, advantages & suitability in embedded application The Acorn RISC machine, ARM architechture, ARM7TDMI features, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, operational Modes, The ARM programmer's model, ARM development tools.

Unit - II

ARM Assembly Language Programming: ARM instruction types – data transfer, data processing and control flow instructions, ARM instruction set, Coprocessor instructions, Addressimg modes, Thumb programming model, Thumb instruction set, inline assembly in C, Embedded Assembly in C, ISRs in C.

Unit – III

3-stag pipeline ARM organization, 5-stage pipeline ARM organization, Understanding of ARM instruction execution, Exceptions in ARM.

Unit - IV

I/O Devices of ARM processor: General purpose I/O, Timers and counters, Watchdog timer, PWM device, Interrupt controllers, A/D and D/A converters, Serial communication devices.

Unit – V

Salient features of LPC 2148, Pin Description of 2148 CPU, Architectural Overview - Memory Mapping -BlockDiagram, features of different blocks LPC 2148 – Peripherals, Description of General Purpose Input/output Ports (GPIO) Features, register description & operation of PLL, timers, PWM, RTC, ADC, DAC & SPI.

Textbooks/ Reference Books:

1. ARM System Developer's Guide Designing and Optimizing System Software, Andrew N. Sloss, Dominic Symes, Chris Wright and John Rayfield, Elsevier, 2004.
2. ARM Architecture Reference Manual, David Seal, Pearson Education, 2007.
3. ARM System-on-Chip Architecture, Second Edition, by Steve Furber, Pearson, 2013

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Biomedical Engineering, V-Semester

BM-5004 Biomedical Equipments

COURSE CONTENT

Unit I

Fundamental of Medical Instrumentation:

Sources of Biomedical Signals, Basic Medical Instrumentation System, Performance Requirement of Medical Instrumentation System, General Constrains in Design of Medical Instrumentation System, Regulation of Medical Devices.

Bioelectric Signals and Electrodes:

Origin of bioelectric Signals, Recording Electrodes-Silver- Silver Chloride
Electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes for EMG, Electrical Conductivity of Electrode jellies & creams, Microelectrodes.

Recording System:

Basic Recording System, General Consideration for Signal conditioner, Sources of noise in low level measurement, Writing System, Direct writing recorders, The ink jet recorder, Potentiometer recorder, Digital Recorders, Instrumentation tape recorder.

Unit II

Biomedical Recorders:

Electrocardiograph, cardiograph vector, Phonocardiograph, Electroencephalograph, Electromyograph.

Patient Monitoring System:

System Concept, Cardiac monitor, Bed side Patient Monitoring System, Central monitors, Measurement of heart rate, Measurement of pulse rate, Blood pressure measurement, Measurement of temperature, Measurement of respiration rate. Catheriazation Laboratory Instrumentation.

Arrhythmia & Ambulatory Monitoring Instruments:

Cardiac Arrhythmia, Arrhythmia Monitor, QRS detection techniques, Exercise detection technique, Exercise stress testing, Ambulatory Monitoring Instruments.

Foetal Monitoring Instruments:

Cardiotocograph, Methods of Monitoring Foetal heart rate, Monitoring labour activity, Recording System

Unit III

Biomedical Telemetry & Telemedicine:

Wireless Telemetry, Single Channel Telemetry, Multi-channel Wireless Telemetry System, Multi-patient Telemetry, Implantable Telemetry Systems, Transmission of analog physiological Signal over telephone, Telemedicine.

Patient Safety:
Electric Shocks Hazards, Leakage Currents, Safety Codes for Electromedical Equipment, Electrical Safety Analyzer. Testing of biomedical Equipments.

Unit IV
Oximeters
Oximetry, Ear Oximetry, Pulse Oximeter, Skin Reflectance Oximeters, Intravascular Oximeter.
Blood Flow Meter:
Electromagnetic Blood flow meter, Types of Electromagnetic Flow meters, Ultrasonic Blood Flow meters, NMR Blood Flow meter, Laser Doppler Blood Flow meter.
Cardiac Output Measurement:
Indicator Dilution Method, Dye Dilution Method, Thermal Dilution Techniques, Measurement of Continuous Cardiac Output Derived from the Aortic Pressure Waveform, Impedance Technique, Ultrasound Method.

Unit V
Pulmonary Function Analysers
Pulmonary Function Measurement, Spirometry Pneumotachometer, Measurement of Volume , Pulmonary Function Analyzers, Respiratory Gas Analyzer.
Audiometers and Hearing Aids:
Mechanism of Hearing Measurement of Sound, Basic Audiometer, Pure Tone Audiometer, Speed Audiometer System Bekesy, Evoked Response Audiometry System, Calibration of Audiometers, Hearing Aids.

Reference Books:

1. R.S. Khandpur, " Hand Book of Biomedical Instrumentation. TMH
2. Carr J.J. Brown J.M., " Introduction to Biomedical Equipment Technology" Asea Parson
3. Chromwell, Weibell & Pfeiffer," Biomedical Instrumentation and Measurements" PHI
4. Togawa, Tamura & Oberg – Biomedical Transducers & Instruments – CRC Press Boca Raton, New York
5. R. Aston principle of Biomedical Instrumentation and Measurement.
6. J.G. Wabster, Encyclopedia of Medical DevicesVolI, II and III, Wiley Interscience publication, 1988.
7. Geddes and Baker "Principles of applied Biomedical instrumentation" John Wiley & Sons

List of Experiments:-
1. To measure blood pressure by sphygmomanometer.
2. Record ECG of patient using limb leads.
3. Record ECG of patient using chest leads.
4. To find blood oxygen saturation level using finger plethysmograph.
5. Study of PCG.
6. To measure various respiratory capacity & volume using Spiro meter.
7. Study of EEG.
8. To find EPR or ERP using EEG.
9. Study of blood flow meter.
10. to measure nerve conduction velocity.

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Biomedical Engineering, V-Semester

Elective-I BM-5005 (1) Control System

Unit-I

Basic idea of control systems and their classification - differential equations of systems - linear approximation - Laplace transform and transfer function of linear system - Model of physical system (Electrical, mechanical and electromechanical)- block diagram - signal flow graph - Mason's gain formula - return difference and return ratio.

Control system components :- Error detectors , servomotor, tachogenerator, servo amplifier, magnetic amplifier, rotating amplifier.

Unit-II.

Time domain analysis - Representation of deterministic signals - First order system response - S-plane root location and transient response - impulse and step response of second order systems - performance - characteristics in the time domain - effects of derivative and integral control - steady state response - error constant - generalised definition of error coefficients - concepts of stability - Routh - Hurtwitz criterion.

Unit-III.

Frequency domain analysis - frequency response - Bode plot, Polar plot, Nicol's chart - closed loop frequency response and frequency domain performance characteristics . Stability in the frequency domain . Nyquist criterion.

Unit-IV.

Root locus method - Basic theory and properties of root loci - procedure for the construction of root loci - complete root locus diagram. Design and compensation of feedback control system :- approaches to compensation - cascade compensation networks and their design in the frequency domain - simple design in S-plane.

Unit-V.

State variable methods:- introduction to state variable concepts - state variable description of linear dynamic systems - representation in matrix forms - block diagram and signal flow graph representation of state equations - Transfer matrix from state equations - transition matrix - general solution for linear time invariant state equations. Basic principles of adaptive control systems.

Suggested Books/References

1) Ogata K, " Modern Control Engineering", Prentice Hall
2) Kuo B. C , "Automatic Control System", Prentice Hall
3) Nagarath & Gopal, " Control System Engineering", Wiley Eastern

PROGRAMME: Biomedical Engineering- V Semester

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Biomedical Engineering, V-Semester

Elective-I BM-5005 (2) Biomedical physics

Unit-I

Bioelectricity: Theory of diffusion & permeability through biological membrane, Resting Membrane potential, Generation & transmission of impulses, Ionic channels, monophasic and biphasic recordings, Electrical activity of the heart Pace maker potential, Electrocardiography. Biological transducers, Receptor potentials. Electrical activity of the brain, Hodgin- Huxley model of squid giant axon. Contemporary models of neurons Synaptic transmission.

Unit-II

Elasticity of living cell materials ,Elasticity and braking strength of bones, Muscle as a helical spring, Introduction of biomaterials, Structure and properties of material used as implants: Polymer, Ceramics, Metals composite bone cements , Tissue material. Tissue responses to implant, Cellular responses to foreign soft and hard tissues, uses of implants, Viscosity of Elemental protoplasm and its determination in cell, Role of viscosity in preparation and use of Pharmaceuticals, Surface energies of living materials, Surface tension of Bio-Fluids and its measurement.

Unit-III

Radiation Biophysics-Radio Emission – Law of radioactive decay half life period- Production of radioisotopes for medical use, Generation & sources of electromagnetic radiation, Interaction of radiation with matter and tissue, Useful and harmful effects of magnetic fields, Radio waves, Micro waves, Ultraviolet radiation and infrared red thickness- Photo electric, Compton and pair production process and their significance in radiology. Radiation units- Detection and measurements of radiation.

Unit-IV

Fluid Biophysics System, Fluid flow across the membrane, Fick's diffusion equation, coefficient of diffusion and permeability constant and their role in therapeutics, Influence of tubewell, Radius of tube, Length of tube and R.B.C. concentration on blood flow, Total energy equation for blood. The heart as a pump.

Unit-V

Thermodynamics of living System: Living body as a thermodynamics system, Thermodynamic laws applied to bio-systems, Expressions for changes in internal energy and negative entropy change in living systems, Application of heat & mass Transfer principles to biological systems. Heat exchange, between a biological system & environment, Effect of hypothermia and hyperthermia, Production of ultra low and low temperature for medical use.

References:

1. Biophysics; Cotteril, wiley Publisher
2. Methods in modern biophysics- Benget Notling, Springer
3. Biophysics- Pattabhi, Gautham, Kulwer Acad Publisher
4. Massey and Meredeth, “Medical Physics”.
5. David Freifelder, “Molecular Biology”, Johns and Bartlet
6. David Cooney, “Principles of Biomedical Engineering”.
7. Ruch and Patton, “Bio Physics and Medical Physiology”

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Credit Based Grading System

Biomedical Engineering, V-Semester

Elective-I BM-5005 (3) Signal and System

Unit I: Review of basic continuous time and discrete time signals and their properties, the sampling theorem and its implications, spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, aliasing and its effects formalizing systems; System properties: linearity, additively and homogeneity, shift variance, causality, stability, reliability. Introduction to different types of systems like Causal & non causal systems, Static& Dynamic, Stable &Unstable, Linear& Nonlinear, Time variant &Time invariant systems. System representation through differential equations and difference equations.

Unit II: The impulse response and step response, convolution sum, properties of convolution summation, concept of filtering, the moving average system, input-output behavior of the system with periodic convergent inputs, System realization through block-diagram representation and system interconnection. Characterization of causality and stability of linear shift-invariant systems.

Unit III: The Laplace transform for continuous time signal and systems, the notion of Eigen function of LSI systems, a basis of Eigen function, region of convergence, system functions, poles and zeros of system function, and signals, Laplace domain analysis, solution to differential equations and system behavior. Generalization of Parseval's theorem.

Unit IV: Periodic and semi-periodic inputs to an LSI system, the notion of frequency response and its relation to impulse response, Fourier series representation, the Fourier transform convolution/multiplication and their effect in frequency domain, magnitude and phase response, Fourier domain duality. The discrete time Fourier transform (DTFT) and the discrete Fourier transform (DFT). Parseval's theorem. The idea of signal space and orthogonal basis of signals**.**

Unit V: The Z transform for discrete time signals and systems, Eigen functions, region of convergence, system functions, poles and zeros of systems and sequences, Z domain analysis generalization of Parseval's theorem. State space analysis and multi input multi output representation. The state transition matrix.

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Credit Based Grading System

Biomedical Engineering, V-Semester

Elective-I BM-5005 (4) Industrial Electronics

Course content

Unit I
Power, Semiconductor Devices
Classification of Power semiconductor devices, characteristics, construction, application and theory of operation of power diode, power transistor, thyristors. Device specifications and ratings, working of Diac, Triac, IGBT, GTO and other power semiconductor devices. Turn-on / Turn-off methods and their circuits.

Unit II
Rectifiers
Review of uncontrolled rectification and its limitations, controlled rectifiers, half wave, Full wave configurations, multiphase rectification system, use of flywheel diode in controlled rectifier configurations.

Unit III
Inverters and Choppers
Classification of inverters, Transistor inverters, Thyristor inverters, Voltage and Current Communicated inverters, PWM inverters, Principle of Chopper, Chopper classification and types of regulators.

Unit IV
A. C. Voltage Controllers and Cyclo-converters
Classification and operation of A.C. voltage and cyclo-converters, their circuit analysis for different type of load.

Unit V
Industrial Applications
Solid-state switching circuits, Relays, Electronic Timer, battery charger, Sawtooth generator, applications in Industrial process control, Motor drive applications, Electronic regulators, etc., Induction heating, Dielectric Heating, Resistance welding and welding cycle.

Reference Books:

1. Power electronics, converters, applications & design - Need Mohan et.
2. Power Electronics Circuits, devices & applications - M.H. Rashid
3. Power Electronics -P.C.Sen

4. An Introduction Thyristors & their applications - M. Rammurthy
5. Power Electronics & its applications, Alok Jain, Penram Publication

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Biomedical Engineering, V-Semester

BM- 5006 LabView Programming

Introduction to LabView Programming, Program writing concepts, its applications, and various programming examples.