

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Biomedical Engineering, VII-Semester

BM-7001 Medical Imaging

Unit I

X- ray Machine and Digital Radiography: Basis of Diagnostic Radiology, Nature of X-ray, Production of X-rays, X-ray Machine, visualization of X-rays, Dental X-ray Machines, Portable and mobile X-ray units, Physical Parameters for X-ray Detectors, Digital Radiography,

X-ray Computed Tomography: Computed Tomography, System Components, Gantry Geometry, Patient Dose, in CT Scanner

Unit II

Magnetic Resonance Imaging System: Principle of NMR Imaging System, Image Reconstruction Techniques, Basic NMR, Functional MRI (fMRI) Components, Biological effects of NMR Imaging, Advantages of NMR Imaging System.

Unit III

Ultrasonic Imaging System: Diagnostic Ultrasound, Physics of ultrasonic waves, Medical ultra sound, Basic pulse - echo apparatus, A- scan, Echocardiograph, B- scanner, real time ultrasonic Imaging System, Multi- element linear array scanners, Digital Scan converter, Biological Effects of ultrasound.

Unit IV

Thermal Imaging System. Medical Thermography, Physics of thermography, Infrared Detectors, Thermo graphics Equipments, Quantative medical thermography, pyroelectric vidicon Camera, Thermal Camera based on IR Sensor with digital focal plane array.

Unit V

Nuclear Medical Imaging System: Radio Isotopes in medical diagnosis, Physics of radioactivity, radiation detectors, pulse height analyzer, uptake monitoring equipment, radio isotopes rectilinear scanner, the gamma Camera, Multi Crystal Gamma Camera Emission Computed Tomography (ECT), Single Photon emission Computed Tomography (SPECT), Positron Emission Tomography (PET Scanner).

Reference Book:

- 1 Introduction to Biomedical Imaging, By: Andrew Webb.
2. Medical Imaging System. By Macovski, Albert Printz
3. Hand Book of Biomedical Instrumentation .. R.S Khandpur, TMH
4. Essentials physics of medical Imaging By, Jerold T. Bushberg
5. Physics of diagnostics radiology. By, Christensen
6. Biomedical Electronic and Instrumentation by S K Venkataram, Galgotiya pub.
7. Medical instrumentation by S. Ananthi , New Age Pub.

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Biomedical Engineering, VII-Semester

BM-7002 Biomechanics

UNIT I.

Principles of mechanics, viscoelasticity, anisotropy applied to biomaterials. Mechanics of soft and hard tissues. Introduction to two dimensional statics, kinematics and dynamics as applied to musculoskeletal systems. Electromechanical properties of bones, teeth and connective tissues.. Implant tissue biomechanics and crack propagation in bones

UNIT II.

Monitoring Devices: Catheter Mathematical Model, response to a sinusoidal input. Tonometry- different types. Human locomotion - Monitoring & Recording of body movements.- Foot Pressure measurements, Force platform, Pedobarograph, Respiratory Sound measurement.

UNIT III.

Prosthetic Devices: Artificial heart valves- development- different types & testing, Heterografts, Homografts, Development of arterial grafts. Total Hip Prosthesis- Stress analysis & instrumentation, Knee Prosthesis. Muscle mechanics. Neural control movement. limb prosthesis design and control. Cardiovascular mechanics and respiratory mechanics.

UNIT IV.

Orthotic Devices: Scoliosis Measurement and correction procedure, Biomechanics of it's treatment. Exoskeletal system for paraplegics - Powered wheel chairs - crutches & canes.

UNIT V.

Prosthetic devices. Orthopedic orthotic devices. Orthopedic shoes and shoes alternatives, Crutches, canes & wheel chairs

Reference :-

- 1) Alexander R Mc Neill, "Biomechanics", Chapman and Hall, 1975
- 2) DN Ghista , "Biomechanics of Medical Devices" , Macel Dekker, 1982
- 3) A Z Tohen and C T Thomas, "Manual of Mechanical Orthopaedics"
- 4) DN Ghista and Roaf, "Orthopaedic Mechanics", Academic Press
- 5) DJ Schneck and JD Bronzino, Biomechanics: Principles and applications; CRC press
- 6) Aydin Tozeren, Human Body Dynamics: Classical Mechanics and Human Movement, Springer
- 7) Duane Knudson" Fundamentals of Biomechanics, springer

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Biomedical Engineering, VII-Semester

BM-7003 Medical System Modeling

Unit I

Mathematical Modeling: Generalized System Properties, Models with Combination of system Elements, Linear models of physiological System, Distributed parameters verses lumped-parameter Models. Linear System and the Superposition principles. Laplace Transforms and Transfer Function. The Impulse Response and linear Convolution.

Unit II

Static Analysis of Physiological System Introduction, Open -loop Versus Closed loop system, Determination of the steady- State operating Points, Steady state analysis, Regulation of cardiac output, Regulation of Glucose, Chemical regulation of ventilation.

Unit III

Linear red Respiratory Mechanics: Open - Loop Versus Closed Loop, Open loop and closed loop transient response, Description of Impulse and Sep response, open loop Versus Closed -loop Dynamic :Other Consideration

Unit IV

Frequency - Domain response to Sinusoidal Inputs, Graphical Relationship of frequency Response, Frequency response of a model of Circulatory Control, Frequency response of Glucose -Insulin Regulation.

Unit V

Stability and Transient response, root locus plot, Routh -Hurwitz Stability Criterion, Nyquist Criterion for stability, Relative Stability, Stability Analysis of the papillary light Reflex, Model of Cheyne - Stroke Breathing. Case Study: Minimal Model of Blood Glucose Regulation, Closed - loop Identification of the respiratory Control System

Reference Books:

1. Physiological Control System By Micheal C. K. Khoo. PHI
2. Blesser, W.B. A System approach to Biomedicine. McGraw-Hill
3. Milsum, J.H. Biological Control System Analysis. McGraw-Hill

List of Experiments (Using MATLAB simulink):

1. Simulation of Linear Respiratory system model and study dependency of dynamics of airflow, volume etc on breathing rate.
2. Simulation of cardio-vascular system model and study variation of cardiac output volume on change in heart beat rate, pleural pressure, venous return etc.
3. Simulation of cardio-vascular system model and study variation of venous return output on change in heart beat rate, stroke volume etc.
4. Simulation of cardio-vascular system model and study of response under different physiological conditions like exercise; myocardial infarction etc.
5. Simulation of Blood Glucose regulatory system model and study of the variation of blood glucose level under normal, Type-I and Type -II diabetes conditions.
6. Simulation of Blood oxygen regulatory system (Ventilation) model and study of the variation of blood oxygen and carbon di-oxide levels under normal and high altitude breathing.
7. to simulate skeletal muscle reflex model behavior.
8. To simulate Lung mechanics model and analyze time domain response under impulse input.
Consider the model as of Zero, first and second order.
9. To simulate Lung mechanics model and analyze time domain response under step input.
Consider the model as of Zero, first and second order.
10. To simulate iris reflex model under varying light conditions and its stability analysis.

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Biomedical Engineering, VII-Semester

Elective-III BM-7004 (1) Biostatistics

Unit I

The Scope of statistics in biomedical data analysis. Measures of central tendency; Mean, mode etc. Dispersion: Standard deviation, variability, RMS etc.

Unit II

Statistical design of experiments for clinical laboratory data; random allocation, method of allocation without random numbers. Volunteered bias. Cross over design selection and distribution of experimental units.

Unit III

Case control analysis; probability: Normal, Binomial chi² Rican, exponential, Gaussian and Poisson distribution. Analysis of variance (AN OVA) factor analysis. Correlation and Regressaion.

Unit IV

Sampling from normal distribution, T test. Principles of experimental dersign: Introduction, objective of an experimental, different types of error, error control etc.

Unit V

Stastical method orientation and problem oriented illustration for computer aided interfacing.

Reference books:

1. Martin Bland, An introduction to medical statistics, Oxford university Press
2. G. Eason, C. W. Coles, G.gittinby, Mathematics & Statistics for the Bioscience, Ellis Harwood, 1980
3. Chap T. Le. Introductory Biostatistics, Wiley-interscience.
4. Ralph D'Agostino, Tutorials in Biostatistics Vol. I & II, Wiley.
5. Belle. Fisher. Biostatistics: A Methodology for the Health Science, Wiley-interscience.

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Biomedical Engineering, VII-Semester

Elective-III BM-7004 (2) Therapeutic Instruments

Unit I

Cardiovascular system assisting equipments: Need of cardiac Pacemaker, External pacemaker, Implantable Pacemaker, Recent Development in Implantable Pacemaker, pacing System Analyzer.

Cardiac Defibrillators: Need for a Defibrillator, DFC Defibrillator, Implantable Defibrillator, pacer- cardioverter-defibrillator, Defibrillator Analyzer.

Unit II

Therapeutic equipments: Use of High Voltage X-ray Machines, Development of Betatron, Cobalt-60 Machine, Medical Linear Accelerator Machine. High frequency Heat Therapy, Short wave Diathermy, Microwave Diathermy, Ultrasonic Therapy unit, Electrodiagnostic Therapeutic Apparatus, Pain Relief Through Electrical Simulation. Diaphragm pacing by Radio - frequency for Treatment of chronic Ventilatory Insufficiency.

Unit III

Renal system assisting equipments: :Function of the Kidneys, Artificial Kidney, Dialyzers, Membrane for H Haemodialysis, Haemodialysis Machine, Portable Kidney Machines.

Lithotriptors: The Stone Disease Problem, First Lithotriptors machine, Morden Lithotripter System, Extra Corporeal Shock - wave Therapy.

Unit IV

Respiration assisting equipments:: Need for anesthesia, anesthesia Machine, Electronics in anesthesia Machine.

Ventilators: Mechanics of respiration, Artificial ventilation, Ventilators, type of ventilators, Pressure- volume- flow Diagrams, modern Ventilators, High frequency ventilators, Humidifiers nebulizers, and aspirators.

Unit V

Operation Theatre Equipments: Principles of Surgical Diathermy, Surgical Diathermy machine, Safety aspect in Electro- Surgical Units, Surgical Diathermy Analyzers, Laser Applications in Biomedical field. The laser- pulsed Ruby laser, Nd- YAG Laser, Helium- Neon Laser, Argon Laser, Co2 Laser, Excimer Lasers, Semiconductor Lasers, Laser Safety.

Automated Drug Delivery System: Infusion Pumps, Components of Drug infusion System, Implantable infusion System, Closed -loop Control in infusion System.

Reference Books:

1. RS Khandpur, " Hand Book of Biomedical Instrumentation. TMH
2. Carr JJ, Brown JM, " 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. Mushin, " Automation Ventilation of Lungs", Black Well
6. Goldman, "Biomedical Laser", Springer Verlag,
7. Massey & Meredith, "Fundamental Physics of Radiology", Write, Bristol.

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Biomedical Engineering, VII-Semester

Elective-IV BM-7005 (1) Bioinformatics

Unit I

Introduction to Bio-informatics: Objectives of Bio-informatics; Data integration; Data Analysis; Bio-informatics databases and tools; Molecular approach versus Bio Informatics approach; Overview of Bio-informatics application.

Unit II

Molecular biology and Information: Basic chemistry of nucleic acids; Structure of DNA; Genes-The functional elements in DNA; DNA sequencing and Polymeric chain reaction; Cloning methodology; Amino acids; Protein structure; Protein folding function.

Unit III

Linux system and Programming with Perl: The basics of Linux system; Text processing; Writing Shell programs; Introduction to Pen; Programming with Perl; Perl applications for Bio-informatics; BioPerl. Sequence Alignment: Introduction to Sequence Analysis; Models for sequence analysis and their Biological motivation; Methods of alignment; usage of gap penalties and Scoring matrices; Tools for sequence alignment; Tools for multiple sequence alignment; Applications of Multiple alignment.

Unit IV

Gene Mapping and Gene expression: Applications of Gene mapping; DNA sequencing; DNA micro arrays; Algorithms for gene alignment; Gene prediction tools; Tools for DNA/RNA structure and function analysis.

Unit V

Proteomics: Protein structure visualization; Protein structure prediction; Methods of Protein structure for known folds; Methods of protein structure for unknown folds; Methods for structure prediction; Protein analysis; Tools for protein analysis.

Reference books:

1. Bio-informatics. Concepts, Skills and Applications. By: S.C. T. Rastogi, Namita Parag Rastogi. CBS Publication.
2. Bio-informatics: A practical guide to the Analysis of Genes and Proteins. By: Baxevanis A.D., Francis Ouellette. Wiley Interscience, New York.
3. Introduction to bioinformatics, Attwood, PHI
4. Bio-informatics Sequence and Genome Analysis. By: Mount David. Cold Spring Harbor Laboratory Press.
5. Bio-informatics Basics Applications in Biological Science and Medicine. By: Rashidi, Hooman and Lukas K. Buehler. CRC Press.
6. Beginning Perl for Bio-informaties. By: James Tinsdall. O'Reilly publication.

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Biomedical Engineering, VII-Semester

Elective-IV BM-7005 (2) Biomedical Signal Processing

Introduction: Origin of Bioelectric signal and their characteristics. Noise coupling, power line and other interfacing sources. Artifacts. Analysis of concurrent couple and correlated processes.

Unit II

Various amplifier configuration. Signal Conversion, Digitization method and fundamentals of digital Signal processing.

Unit III

Filtering technique for removal of noise, artifacts and interferences. Time domain and frequency domain filtering. Notch & frequency domain filtering. Notch & Comb filters & their design. Optimal and Adaptive filtering technique.

Unit IV

Detection of events in bioelectric signals like ECG, EEG, PCG etc. Detection of waves, correlation & coherence analysis, Few case studies.

Unit V

Wave shaping, envelope extraction and analysis. Processing of events related potentials.)SP techniques for Biomedical Signal. Pattern detection and classification.

Unit VI

SNR consideration. SNR improvement method. Protection circuit for electrical safety. :MI/EMC regulation Case Studies.

Reference Books:

1. Biomedical Signal Analysis- A case study approach, Rangaraj M. Rangayyan, EMB, WSE, Wiley.
2. Biomedical Digital Signal Processing, Wills J. Tompkins, PHI
3. Medical Instrumentation: Application & Design, Webster JG, 3e, Wiley NKY.
4. Signals & System Analysis in Biomedical Engineering, Robert B. Northrop, CRC Press.
5. Microelectronics Circuit, Sedra Smith, Oxford Press