Contents

(BM-100) - Introduction to Biology For Pre-Engineering

Course Outline:

Theory:

1. **Cell Structure and Function**
    1. Techniques used in Cell Biology
    2. Cell Wall and Plasma Membrane – The Boundary Wall
    3. Cytoplasm and Organelles
    4. Prokaryotic and Eukaryotic Cells
2. **Biological Molecules**
    1. Biological Molecules in Protoplasm

2. Importance of Water (Importance in Protoplasm and in Environment)
3. Carbohydrates
4. Proteins
5. Lipids
6. Nucleic Acids
7. Conjugated Molecules (Glycolipids, Glycoproteins, Lipoproteins and Nucleoproteins)

3. **Enzymes**
    1. Structure of Enzymes
    2. Mechanism of Enzyme Action
    3. Factors affecting the Rate of Enzymatic Action (Temperature, pH, Enzyme Concentration and Substrate Concentration)
    4. Enzyme Inhibition (Competitive and Noncompetitive Inhibitors)
    5. Classification of Enzymes
4. **Bioenergetics**
    1. Aerobic and Anaerobic respiration
    2. Mechanism of Respiration
    3. Synthesis of ATP – Chemiosmosis and Substrate-level Phosphorylation
5. **Biodiversity**
    1. Acellular life
    2. Prokaryotes
    3. Diversity among animals
    4. Digestion
    5. Circulation
    6. Immunity
    7. Respiration
    8. Homeostasis
    9. Support and movement
    10. Nervous coordination
    11. Chemical coordination
6. **Continuity in Life**
    1. Reproduction
    2. Development and aging
    3. Inheritance
    4. Chromosome and DNA
    5. Evolution
7. **Application of Biology**
    1. Gene Cloning (Recombinant DNA Technology and Polymerase Chain Reaction)
    2. DNA Sequencing
    3. DNA Analysis
    4. Genome Maps
    5. Tissue culture
    6. Transgenic bacteria, plants and animals
    7. Biotechnology and healthcare
    8. Scope and importance of biotechnology
    9. Vaccination and integrated disease management
    10. Animal husbandry
    11. Latest techniques applied to enhance crop and fruit yields
    12. Home gardening
    13. Role of microbes in human welfare

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended and Text Books:

1. AS/A level Biology, Mary Jones, Contributors: Richard Fosbery, Jennifer Gregory, Dennis Taylor Edition 2, Cambridge University Press, 2007, ISBN 0521703069, 9780521703062
2. National Curriculum 2006, HEC Pakistan
3. AQA A-Level Biology, Pauline Lowrie, Mark Smith

(BM-101) - Introduction to Biomedical Engineering

Course Outline:

Theory:

1. **Biomedical Engineering**
    1. What is biomedical engineering
    2. Branches of biomedical engineering
    3. Role of biomedical engineer
2. **Devices used in Biomedical Engineering**
    1. Biomedical instrumentation fundamental
    2. Critical care devices used in biomedical engineering
    3. Radiological instrumentation.
    4. Diagnostic biomedical devices
    5. Therapeutic Biomedical devices
3. **Applications of Biomedical Engineering**
    1. Rehabilitation Engineering
    2. Physiological modelling and simulation
    3. Biomedical signal processing
    4. Clinical Engineering
    5. Biomaterials
    6. Biomechanics
    7. Tissue Engineering and regenerative medicine
    8. Neural engineering
    9. Medical Image Processing

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Guest Speaker
- Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Text and Reference books::

1. Introduction to Biomedical Engineering, 4th Edition, John Enderle
2. Biomedical Engineering Handbook Volume I & II, J. D. Bronzino

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(BM-108) - Computer Aided Engineering Drawing

Course Outline:

Theory:

1. **Introduction**
    1. Introduction to Engineering Drawing
    2. Use of drawing instruments and materials.
    3. Basic Tools- classification and brief description
    4. Lines, Types of lines, configuration of lines and their application, Selection of line thickness
2. **Engineering Geometry**
    1. Geometric construction
    2. Coordinate systems
    3. Basic entities
    4. Drawing simple geometric objects
    5. Introduction to different types of scales.
3. **Modelling Fundamentals**
    1. Introduction to solid modelling
4. **Multiviews and Visualization**
    1. Projection theory
    2. Projection of principal views from 3D models
    3. Orthogrpahic projections
    4. Isometric drawings
    5. Section views
5. **Dimensioning and plotting**
    1. Dimensioning
    2. Plotting and printing

Suggested Teaching Methodology:

- Lecturing
- Lab tasks
- Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Text and Reference Books:

1. A Textbook of Engineering Drawing: Along with an Introduction to AutoCAD (2015) by Roop Lal, Ramakant Rana
2. Mastering Autodesk Inventor 2015 and Autodesk Inventor LT 2015: Autodesk Official Press, Curtis Waguespack, ISBN: 978-1-118-86213-1

3. Engineering Drawing and Graphic Technology-International Edition, Thomas E. French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, Inc.1993 ISBN 0-07-022347-5

4. Engineering Drawing and Design-Sixth Edition, C. Jensen, J.D. Helsel, D.R. Short, McGraw-Hill, 2002, ISBN 0-07-821343-6 (T 353 J47 2002)

5. Technical Drawing-Fourteenth Edition, F. E. Giesecke, A. Mitchell, H. C. Spencer, I.L. Hill, J.T. Dygdon, J.E., Novak, Prentice-Hall, Inc., 2012, ISBN 0-13-178446-3 (T 353 T43 2003)

(BM-113) - Engineering Mechanics

Course Outline:

Theory:

1. **Introduction:**
    1. General principles;
    2. units of measurement;
    3. Force Vectors:
    4. Addition of vectors;
    5. Cartesian vectors;
    6. Free vector;
    7. Position vectors;
    8. Force directed along a line.
2. **Equilibrium of a Particle:**
    1. Conditions for the equilibrium;
    2. Free body diagram; 3D force systems;
    3. Force system resultants;
    4. Moment of force;
    5. Virognon's theorem; cross product;
    6. Moment of a couple;
    7. Equivalent systems.
3. **Equilibrium of a Rigid Body:**
    1. Equilibrium in 2D and 3D;
    2. Constrains for a rigid body;
    3. Redundant and improper constraints.
4. **Friction:**
    1. Types of friction;
    2. Angle of repose;
    3. Application of friction.
5. **Kinematics of a Particle:**
    1. Rectilinear motion;
    2. Curvilinear motion;
    3. Motion of projectile;
    4. Absolute dependent motion of two particles.
6. **Kinetics of a Particle:**
    1. Equation of motion for a system of particle;
    2. Equation of motion in rectangular, cylindrical, normal and tangential coordinates;
    3. Principles of work and energy for a system of particles;
    4. Linear momentum;
    5. Conservation of momentum;
    6. Impact;
    7. Angular momentum;
    8. Kinematics of a rigid body;
    9. Translation;
    10. Rotation.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference books:

Engineering Mechanics Statics; R. C. Hibbeler, 12th ed. 2007, Pearson Prentice Hall. Engineering Mechanics Dynamics; R. C. Hibbeler, 12th ed. 2007, Pearson Prentice Hall.

(BM-114) - Anatomy

Course Outline:

Theory:

1. **Introduction**
    1. Anatomy and its branches
    2. Anatomical positions
    3. Planes
    4. Topography
2. **Cell Anatomy**
    1. Overview of Cellular Anatomy.
3. **Extremities (Upper and lower)**
    1. Bones
    2. Muscles
    3. Ligaments
    4. Tendons
    5. Bursae
    6. Reticulae
    7. Capsules
    8. Arteries
    9. Veins
    10. Lymphatic system
4. **Vertebral Anatomy**
    1. Vertebrae
    2. Pelvic girdle
    3. Spinal cord
    4. Nervous system
5. **Thorax-Thoracic Viscera**
    1. Surface anatomy
    2. Bones surface musculature
    3. Lungs
    4. Heart
6. **Abdomen**
    1. Organs location
    2. Structures
    3. Relations and function
7. **Head & Neck**
    1. Bones
    2. Muscles
    3. Cranial nerves

List of Practicals:

1. Demonstration of Human Skeleton in general.
2. Demonstration of basic structures in Human Anatomy (Skin, Muscles & Other Structures).
3. Demonstration of Anatomical planes & positions.
4. Demonstration of Movements & Motinal Terms.
5. Demonstration & Study of Scapula & Clavicle.
6. Demonstration & Study of Humerus bone.
7. Demonstration of Ulna and Radius.
8. Demonstration of wrist & hand bones.
9. Demonstration of Pelvic bone.
10. Study and demonstration of Femur bone.

11. Study and demonstration of Tibia & Fibula.
12. Demonstration of Foot bones.
13. Demonstration of skull.
14. Demonstration & study of different parts of Vertebral column.
15. Study and Demonstration of different Models.
16. Audio & Visual Demonstration of Human Anatomy.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference books:

1. Medical Terminology: A Living Language (6th Edition) [Bonnie F. Fremgen and Suzanne S. Frucht], ISBN: 978-0134070254
2. New Biology for Engineers and Computer Scientists [Aydin Tozeren and Stephen W. Byers], ISBN: 978-0130664631
3. Gerard J. Tortora, Principles Of Human Anatomy, 13th Edition, ISBN: 9781118344996
4. B. D. Chaurasia, BD Chaurasia's Human Anatomy: Vol. 1, 6th Edition, ISBN: 9788123923307
5. Frederic H. Martini, Human Anatomy, 8th Edition, ISBN: 9780321883322
6. Elaine N. Marieb, Human Anatomy, 8th Edition, ISBN: 9780134243818
7. Michael McKinley and Valerie O'Loughlin, Human Anatomy, 4th Edition, ISBN: 9780073525730

(BM-115) - Physiology-I

Course Outline:

Theory:

1. **Introduction**
    1. The Cell and General Physiology
    2. Functional organization of human body and control of the internal environment
    3. Cell and its function, protein synthesis and cell reproduction
    4. Metabolism of carbohydrates and formation of ATP
    5. Lipid and Protein Metabolism, transport through Cell membrane
2. **Human physiology from a system's view point**
    1. Quantitative issues at the organ and whole body levels of Cardiovascular
    2. Respiratory
    3. Renal
    4. Digestive systems
3. **Nerve and Muscle**
    1. Membrane potential
    2. Action potential
    3. Excitation and Rhythmicity
    4. Contraction of Skeletal and cardiac muscles, sliding filament Mechanism, Heart as a pump
4. **Sensory Systems**
    1. Sensory Receptors
    2. Classification and basic mechanism of action
5. **Somatic Sensations**
    1. Mechanoreceptive sensations, pain, thermal and visceral pain, headache
6. **Special Senses**
    1. Eye, receptor function of the retina, Neurophysiology of Vision, the Chemical Sense-taste and smell

List of Practicals:

1. Use of stethoscope & measurement of human arterial blood pressure & pulse
2. Determination of Red Blood Cells per cmm of human Blood
3. Determination of White Cells per cmm of human blood
4. Determination of haemoglobin percentage in human blood
5. Physiochemical & microscope analysis of human urine sample (Renal System)
6. 1. Demonstration of the use of ECG,
    2. Test of hearing
7. Determination of visual acuity of a human subject by using snellen's eye chart
8. Determination of bleeding time in human body
9. Determination of the coagulation time in human body
10. 1. To record normal respiration & effect of System exercise on it using spirometer.
    2. To record normal respiration & effect of exercise on it using power lab.
11. Introduction the organization & classification of neurons using neurolab
12. To demonstrate the differential count of leukocytes in human blood Sample
13. To observe the shape of RBC in normal saline stem

14. To identify various parts of digestive tract & to observe cut mobility in exposed abdomen of dissected rabbit
15. To determine the group of blood sample

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Physiology for Engineers: Applying Engineering Methods to Physiological Systems (Biosystems & Biorobotics) [Michael Chappell and Stephen Payne], ISBN:978-3319261959
2. Quantitative Human Physiology: An Introduction [Joseph J Feher], ISBN:978-0123821638
3. John E. Hall, Guyton and Hall Textbook of Medical Physiology, 13th Edition, ISBN: 9781455770052
4. Elaine N. Marieb, Essentials of Human Anatomy & Physiology, 11th Edition, ISBN: 9780321919007
5. Arthur B. Ritter, Physiology for Engineers: A Systems Approach, 2017, ISBN: 9781498734561

(BM-116) - Physiology-II

Course Outline:

Theory:

1. **Nervous System**
    1. Organization of Nervous System
    2. Basic functions of synapses
    3. Neuronal Mechanism and circuits for processing information
2. **Motor Functions**
    1. Spinal cord and the cord reflexes
    2. The cerebral cortex and intellectual functions of the Brain
    3. Motor function of the Brain stem
    4. Vestibular control of postural reflexes
    5. Cerebrum and basal ganglia
    6. Reticular
3. **Somatic Sensations**
    1. Mechanoreceptive sensations
    2. Pain
    3. Thermal and visceral pain
    4. Headache
4. **Behavioral functions of the Brain**
    1. Limbic System
    2. Role of the Hypothalamus
    3. Control of the vegetative functions of the body
    4. The Autonomic nervous system
    5. The Adrenal Medulla
    6. Electrical Activity from Brain
5. **Endocrinology and Reproduction**
    1. Introduction to Endocrinology and the pituitary Hormones;
    2. Hormonal functions in male and female

List of Practicals:

1. Study of kymograph
2. Recording of simple muscle twitch in Gastrocnemius sciatic nerve preparation
3. Recording of the effect of two successive stimuli on the nerve muscle preparation
4. Recording of the effect of continuous stimuli (fatigue) in a nerve muscle preparation
5. To demonstrate phenomenon of tentanisation
6. Effect of temperature on the simple muscle twitch
7. Demonstrate the superficial reflexes on a given subject
8. Demonstrate the deep reflexes on a given subject
9. To observe the receptor adaptation associated with Paccinian Corpuscle and other receptors in a computer simulated program
10. To illustrate the principle of phase locking in auditory fibers by using the compute simulated program
11. Determination of visual field in human subject.
12. Observe and study the spectrum and waveforms of different vowels sound and their relationship with the configuration of the vocal tract

13. Study the movement in basilar membrane during the passage of sound waves of different frequencies, on a simulated mode
14. a) To calculate nerve conduction velocity from twitch records obtained by using a nerve-muscle preparation using Kymograph. (b) To calculate nerve conduction velocity from twitch records obtained by using a nerve-muscle preparation using powerlab.
15. To locate the gustoreceptors in the human
16. (a) To calculate nerve conduction velocity from twitch records obtained by using a nerve-muscle preparation using Kymograph. (b) To calculate nerve conduction velocity from twitch records obtained by using a nerve-muscle preparation using powerlab. To locate the gustoreceptors in the human
17. Demonstration of the recording of an (extracellular) action potential from frog sciatic nerve (monophasic & biphasic) on oscillograph / oscilloscope
18. Study of reflex movements in spine of frog; Effect of acid treatment, Effect Effects of electric shock & Effect of Strychnine

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing ## **Suggested Assessment:**

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Text book of Medical Physiology by Guyton and Hall (13th Edition).
2. Essential of Medical Physiology by Jaypee (6th Edition).
3. William F, “Review of Medical Physiology”.

(BM-203) - Cellular and Molecular Biology

Course Outline:

Theory:

1. Basic properties of cells
2. Prokaryotic and eukaryotic cells
3. Viruses
4. Biological molecules: carbohydrates, lipids, proteins, and nucleic acids, Techniques used in cell and molecular biology
5. Enzymes
6. Metabolism
7. Mitochondrion structure and function
8. Chloroplast structure and function
9. Plasma membrane composition, structure, and function
10. The movement of substances across cell membranes
11. The endomembrane system
12. The extracellular matrix
13. The structure and function of the nucleus
14. Genes and chromosomes
15. DNA replication
16. Transcription, Translation
17. Cytoskeleton and cell motility
18. Cellular reproduction
19. Cell signalling

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing ## **Suggested Assessment:**

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Reference Text Book:

1. H. Lodish et al. 2012. Molecular Cell Biology, 7th Ed. W.H Freeman and Company, and Turning
2. Molecular Biology of the Cell (MBC) 5th Edition, 2008 Alberts, Johnson, Lewis, Raff, Roberts, Walter.

(BM-208) - Biomedical Electronics

Course Outline:

Theory:

1. **Operational Amplifiers**
    1. Analysis of OP-AMP action
    2. OP-AMP specifications
    3. Interpreting OP-AMP data sheet
    4. Offset voltage and current
    5. Temperature rating
    6. Output swing
    7. Gain, CMRR
2. **Basic OP-AMP Configuration Circuits**
    1. Inverting amplifiers
    2. non-inverting amplifiers
    3. Voltage follower
    4. Summing amplifiers
    5. Integrator and differentiator
3. **Instrumentational Amplifier**
    1. Sensing and Measuring with the instrumentation amplifier
    2. Instrumentation amplifier as a signal conditioning circuit
4. **Active Filters Design**
    1. Basic Low Pass filters
    2. Introduction to Butterworth filters
    3. High pass and Bandpass Butterworth filters
    4. Notch filters
5. **A/D and D/A converters**
6. **Selected Applications of OP-AMPs in Biomedical Engineering**
7. **Signal Acquisition and Conditioning of ECG using OP-AMPs**

List of Practicals:

1. Design and Analyze OP-AMP Based Inverting Amplifier
2. Design and Analyze OP-AMP Based Non-Inverting Amplifier
3. Design and Analyze the characteristics of Summing Amplifier
4. To study Characteristics of Differential Amplifier
5. To determine common mode rejection ratio (CMMR)
6. Design and Analyze OP-AMP Based Integrator
7. Design and Analyze OP-AMP Based Differentiator
8. Design and Analyze Instrumentation Amplifier
9. Designing an ECG Amplifier.
10. To Analyze Analog to Digital Converter
11. To Analyze Digital to Analog Converter
12. Designing and analyzing frequency response of Active Low Pass Filter
13. Designing and analyzing frequency response of Active High Pass Filter
14. Designing and analyzing frequency response of Active Band Pass Filter
15. Designing and analyzing frequency response of Active Band Stop Filter/
16. Project : ECG/EMG/ EOG/PPG Amplifier and filters

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Electronics Design by Floyd 9th Edition
2. Operational amplifier and linear integrated circuits by Robert Coughlin

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(BM-209) - Basic Electronics

Course Outline:

Theory:

1. **Semiconductor Theory**
    1. Introduction,
    2. Intrinsic and Extrinsic Semiconductors,
    3. Doping and energy levels.
2. **Diodes**
    1. PN junction/ Biased PN junction,
    2. V-I Characteristics,
    3. Load Line and dynamic resistance.
    4. Diode models, Reverse recovery time and temperature effects,
3. **Diode Applications**
    1. Half wave and Full wave rectifiers,
    2. Clippers and Clampers, Logic gates.
4. **Bipolar Junction Transistors**
    1. Construction, operation and characteristics,
    2. Amplifying action and variation in current gain,
    3. Common Emitter, Common Collector and Common Base Configurations. Power Ratings.
5. **BJT Biasing Circuits**
    1. Fixed Bias, Voltage Divider Bias and Emitter feedback Bias Circuits,
    2. DC load line and operating point,
    3. Biasing circuit design and stabilization, Transistor as a switch
6. **BJT Small Signal Analysis**
    1. Common Emitter Amplifier, Common Base Amplifier, Common Collector Amplifier, Amplifier Design and Loading effects,
7. **Field Effect Transistors**
    1. JFET Construction and Operation,
    2. Transfer characteristics and parameters,
    3. FET Biasing Circuits, Fixed Bias,
    4. Self-Bias and Voltage divider Bias
8. **Design of a bias circuit**
    1. FET Small Signal Analysis,
    2. JFET/Depletion MOSFET small-signal model,
    3. Common source, common drain and common gate amplifiers,
    4. Loading effects and design of amplifier circuits.
9. **Differential Amplifiers**
    1. Darlington transistor circuit, properties of differential amplifier stage,
    2. Circuits of differential amplifiers using BJTs and FETs.
10. **Oscillators:**
    1. Hartley oscillators,
    2. Colpitt oscillators,
    3. RC phase shift oscillators,
    4. Wein-Bridge oscillators,
    5. Crystal oscillators based on BJT and FET.

List of Practicals:

1. To observe the working of diode with forward and reverse bias.
2. Plot the diode characteristic curve.
3. Calculate the bulk resistance of the diode and observe its effect in the diode approximations.
4. To observe the working of half wave rectifier.

5. To observe the working of full wave rectifier
6. To observe the working of Bridge wave rectifier.
7. To observe the working of Zener Diode
8. To analyze the working of Clamper Circuit.
9. To analyze the wrking of Clipper Circuit.
10. To determine the output voltage for half wave voltage doubler.
11. To determine the output voltage for full wave voltage doubler.
12. To determine the output voltage for Zener limiting circuit
13. Checking and Troubleshooting the NPN and PNP Transistor using Multimeter.
14. To use the transistor in switching mode.
15. Demonstrate the operation and determine the biasing parameter of Base Bias Circuit.
16. Demonstrate the operation and determine the biasing parameter of Voltage Divider Bias Circuit.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text Book:

1. Electronic Devices and Circuit Theory By H. Boylestad and L. Nashelsky
2. Electronic Devices and Circuits By Theodore F. Bogart, Jr.

(BM-210) - Biochemistry

Course Outline:

Theory:

1. **Introduction to Biochemistry**
    1. Colloidal state, buffer, pH, significance of pH Henderson equation, surface tension, viscosity, osmosis, diffusion, Biological Membrane, active Transport, Chemi-osmotic theory-passive transport concept of chromatographic techniques (TLC, paper chromatography, GLC column chromatography etc.) carbohydrates, amino acids, nucleic acids, proteins, vitamins, enzymes, hormones & signaling agents.
2. **Metabolism of Carbohydrates, Lipids and Proteins**
    1. Carbohydrate Amino acids: structure, and properties. Proteins: primary and secondary structure of proteins. *Enzymes:* Nomenclature, properties, Working, Factors affecting Reaction, Equation and diseases Globular proteins: heme-proteins, hormones & signaling agents.
3. **Conformational analysis and forces**
    1. Conformational analysis and forces that determine protein and nucleic acid structure. Molecular Modeling of protein, nucleic Tertiary and quarterly structure of protein, protein mis- folding.
4. **Carbohydrates**
    1. Introduction, classification and structure. Digestion of carbohydrates. Metabolism of carbohydrates: glycolysis, regulation of metabolism, Overview and reactions of glycolysis, hormonal regulation of glycolysis, Tricarboxylic acid cycle, reactions of TCA, energy and regulation of TCA cycle.
5. **Bioenergetics**
    1. *Bioenergetics:* Thermodynamic principles in human body. Thermodynamics of phosphate compounds (phosphate transfer reactions) and role of ATP for biological energy transfer, thermodynamics of life
6. **Metabolism of Lipids**
    1. Digestion, absorption and secretion. Utilization of dietary lipids
7. **Vitamins**
    1. folic acid, VitaminB12, Vitamin C, Vitamin D, Vitamin B1, Vitamin A, Vitamin E.

List of Practicals:

1. How to prepare the Solution in Lab
2. Determination of pH by pH meter and Litmus paper
3. Demonstration the action of buffer
4. To determine the principle application of Hander son- Haselbash's equation
5. Tests for proteins
6. Examination of Egg white
7. Color reactions for proteins
8. Isolation of Casein from milk
9. Tests on carbohydrates
10. Measurement of Blood Glucose level with help of spectrophotometer
11. Oral Glucose Tolerance Test (OGTT)
12. Tests of Lipid profile by chemical analyzer
13. Separation of Amino Acids by chromatographic methods.
14. Open ended lab I
15. Open ended lab II
16. Open ended lab III

Suggested Teaching Methodology:

- Lecturing

- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Lippincott, Bio-Chemistry 5th Ed,2010 Donald Voet, Judith, G. Voel and Charlotte, W. Prats,
2. Fundamentals of Biochemistry, 2006, John Wiley & Sons. Rodney Boyer,
3. Modern Experimental Biochemistry, Pearsons Education, Delhi, India. Tsai. C. Stan,

(BM-306) - Bio-Instrumentation and Measurements - I

Course Outline:

Theory:

1. **Introduction to measurements**
    1. Precision
    2. Resolution
    3. Sensitivity
    4. Accuracy
    5. Uncertainty
2. **Bio-potentials, biosensors and transducers**
    1. Biomedical signals of the human body,
    2. Sensors and transducers for bio-potential measurements
    3. Problems encountered in measuring biopotentials of the human body
    4. Invasive and noninvasive measurement techniques and related equipment.
    5. Functional Building blocks of a Biomedical Instrumentation System
3. **Cardiovascular System Devices**
    1. Diagnostic: Electrocardiography, Measurement of Blood pressure, Blood flow
    2. Therapeutic: Cardiac output. Defibrillator, pacemaker
4. **Pulmonary System Devices**
    1. Diagnostic: Pulmonary Function Analyzer, Spirometry, Ventilation Monitors, Respiration: Pulse oximetry, Capnography,
    2. Therapeutic: Ventilators, Heart lung machine, nebulizer
5. **Musculoskeletal & Nervous System Devices**
    1. EMG
    2. EEG
6. **Critical Care Devices**
    1. Patient Monitoring**:** Patient Monitors, central monitoring system, telemetry system
    2. Surgical/Operation Theatre Devices Equipment**:** Electrosurgical unit
7. **Genito-urinary System Devices**
    1. Hemodialysis Machine
8. **Quality Assurance and Quality Control**
    1. Common defects in medical equipment
    2. Performance measurement
    3. Calibration
    4. Maintenance and repair

List of Practicals:

1. To study the principle of various Biomedical Transducer
2. To understand methods and instruments for body temperature measurement and compare temperature sensor for selection on the basis of their properties
3. To study the working of photo detectors/photo sensors and their application in biomedical
4. To study the techniques of measuring blood pressure and measure the systolic and diastolic pressure.
5. To become familiar with the electrocardiograph as a primary tool for evaluating electrical events within the heart and observe rate and rhythm changes in the ECG associated with body position and breathing.
6. To record maximum clench strength for right and left hands and correlate motor unit recruitment with increase skeletal force.
7. To record EMG response to increased weights lifted by dominant and non-dominant arms and to record EMG when fatigue is induced.
8. To observe respiratory cycle and record breath per minute and respiratory rate in different conditions eupnoea, hyperventilation and apnea Vera.

9. To record an EEG from an awake, resting subject with eyes open and eyes closed. Identify and examine alpha, beta, delta, and theta components of the EEG complex.
10. To record EOG on the horizontal plane and compare eye movements under the following conditions: pendulum tracking & pendulum simulation.
11. To observe respiratory cycle and record breath per minute and respiratory rate in different conditions eupnea, hyperventilation and apnea Vera.
12. To observe real time monitoring through multipara monitor/bedside monitor.
13. To Study the construction and working of x-ray equipment and to practice the safety aspect using standard procedure.
14. To practice the safety aspect of ultrasound machine using standard procedure
15. To observe the principle and working of ventilator.
16. Open ended lab 1

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Recommended Text and Reference Books:

1. Biomedical Instrumentation & Measures 2nd edition by Leslie Cromwell.1980. ISBN: 978-81-203-0653-0.
2. Bioinstrumentation by John G. Webster.2004.ISBN: 978-81-265-1369-7
3. Medical Instrumentation: Application and Design by John G. Webster.4th ed, 2010. ISBN: 978-0-471-67600-3

(BM-307) - Bioinformatics

Course Outline:

Theory:

1. **History and evolution of bioinformatics**
    1. Introduction to databases (Database types, Database formats, DNA databases, European Molecular Biology Laboratory (EMBL)
    2. Genomics
    3. Transcriptomics
    4. Computational proteomics
2. **Pairwise Sequence Alignment**
    1. Evolutionary Basis
    2. Sequence Homology versus Sequence Similarity
    3. Sequence Similarity versus Sequence Identity
3. **Database Similarity Searching**
    1. Unique Requirements of Database Searching
    2. Heuristic Database Searching
    3. Basic Local Alignment Search Tool (BLAST)
    4. FASTA
    5. Comparison of FASTA and BLAST
4. **GenBank and DNA Data base of Japan (DDBJ)**
    1. Protein information Resource (PIR) formats
    2. Protein Sequence (databases, SwissProt, UniProt, UniProtKB/TrEMBL)
    3. Structural databases (Protein Databank (PDB), Structural Classification of Proteins (SCOP) database, Class, Architecture, Topology, Homology (CATH) database)
5. **Introduction to Biomolecules**
    1. Computational Biology : Introduction to Bioinformatics
    2. Protein folding and misfolding
    3. Protein Architecture: Sequence of amino acids
    4. protein interaction.
6. **Structures**
    1. Secondary structure of proteins
    2. Tertiary structure of proteins
    3. Nucleic Acid Structure.
7. **DNAs and RNAs**
    1. Interactions and conformations of DNAs.
    2. Interactions and conformations of RNA.
8. **Computer Simulations of biomolecules**
    1. Classical versus quantum descriptions
    2. Statistical mechanics of biomolecules (e.g., canonical ensemble, ergodicity)
    3. Modeling interaction in protein (Bond-length and bond-angle potentials)
    4. Molecular Dynamics Simulations

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)

- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Practical Exercises (100%)

- Open-Ended Labs

Text and Reference Books:

1. Introduction to Bioinformatics, Arthur M. Lesk, 4th Edition, Oxford University Press, 2014, ISBN 0198724675, 9780198724674
2. Bioinformatics and Functional Genomics, Jonathan Pevsner, 2nd Edition, Wiley, 2009, ISBN 0470085851, 9780470085851.
3. D. Frankel and B. Smit "Understanding Molecular Simulations: From Algorithms to Applications"
4. T. E. Creighton "Proteins" (2nd edition, W.H. Freeman, and Co., New York)

(BM-310) - Control Systems for Biomedical Engineers

Course Outline:

Theory:

1. **Introduction**
    1. Introduction to control systems
    2. Open loop and close loop control systems.
    3. Examples of control systems in Biomedical Engineering.
2. **Modeling in the Frequency Domain**
    1. Electrical/Electronic/Mechanical systems transfer function
    2. Electric circuits analog
3. **Modeling in the Time Domain**
    1. General State-Space Representation and Analysis
    2. Converting a Transfer Function to State Space & vice versa.
4. **Time Response**
    1. Poles, Zeros, and System Response
    2. Transient and steady state response of first and second order systems
5. **Reduction of Multiple Subsystems**
    1. Block Diagrams and reduction techniques
    2. Signal-Flow Graphs and Mason's Rule.
6. **Control System Stability**
    1. Routh-Hurwitz Criterion and Special Cases
7. **Root Locus Techniques**
    1. Root Locus and its Properties
    2. Sketching the Root Locus plots.
8. **Frequency Response Techniques**
    1. Bode and Polar Plots
    2. Stability via the Nyquist Diagram
    3. Gain Margin and Phase Margin

List of Practicals:

1. To be familiar with the Matlab programming and control system toolbox.
2. Find the closed-loop transfer function of the system.
3. To find the impulse and step responses of the control system.
4. To compute the transient response parameters of control systems.
5. To find the partial fraction residues and poles of the system.
6. To find the Eigen values of the system.
7. Transfer function to state space conversion.
8. To find the closed-loop pole locations to check the stability of the system.
9. To obtain the root locus of the system.
10. To obtain the Bode plot of the system.
11. To plot the Nyquist diagram of the system.
12. To find the gain and phase margins of the system
13. Open ended lab 1
14. Open ended lab 2
15. Open ended lab 3
16. Open ended lab 4

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Control Systems Engineering, by: Norman S. Nise, 7th Edition.
2. Modern Control Engineering, by: Katsuhiko Ogata, 5th Edition.
3. Biomedical Applications of Control Engineering, by Selim S. Hacısalihzade

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(BM-311) - Bio-Instrumentation and Measurements - II

Course Outline:

Theory:

1. **Centrifugation techniques**
2. **Electrochemical methods of analysis**
    1. Electrophoresis
    2. Blood banking and transfusion
    3. Chromatography, Liquid chromatography
    4. Gas chromatography
    5. High performance liquid chromatography
    6. Clinical chemistry analyser
    7. Automated cell counter
3. **Spectroscopy**
    1. Spectrophotometry
    2. Flame photometry
    3. Mass spectrometry
    4. Infrared spectrometry
    5. Nuclear Magnetic Resonance Spectroscopy
4. **Microscopy**
    1. Electron microscopy
    2. Atomic force microscopy
    3. Confocal microscopy

List of Practicals:

1. Demonstration and Troubleshooting of centrifuge
2. Separation of Blood components using Centrifuge
3. Hemoglobin separation using Electrophoresis.
4. Design and Development of Virtual Instruments in Lab View.
5. Introduction to Virtual Instrument Designing in Lab View
6. Building Applications using For loops in Lab View
7. Signal Processing using Lab View
8. Analysis of Cefixime Trihydrate using UV Spectrophotometer.
9. Determination of absorption coefficient using UV-spectrophotometer.
10. Wavelength analysis of different light sources using Atomic Spectrometer.
11. Demonstration and working of High Performance Liquid Chromatography (HPLC)
12. Demonstration and working of Hematology Analyzer.
13. Demonstration and working of Chemistry Analyzer
14. Troubleshooting and repair of Medical Equipment
15. Comprehension of documentation and hospital set-up
16. Open Ended Lab 1

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)

- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Mary C. Haven (Editor), et al, Laboratory Instrumentation, 4th ed, 1995. ISBN: 978-81-265-2857-8
2. Cromwell, Bio-Medical Instrumentation & Measures 2. 2nd ed,1980. ISBN: 978-81-203-0653-
3. John G. Webster (Editor), Medical Instrumentation 2. 2nd ed. 2010. ISBN: 978-0-471-67600-3

(BM-312) - Biostatistics

Course Outline:

Theory:

1. **Descriptive Biostatistics**
    1. Introduction to Biostatistics,
    2. Measures of Central Tendency,
    3. Measures of Dispersion,
    4. Frequency Distribution,
    5. Graphical Methods (scatter plot, histogram, bar chart, stem-leaf plot etc.)
2. **Introduction to Probability**
    1. Multiplication and Addition Laws of Probability,
    2. Conditional Probability,
    3. Bayes' Rule and Screening Tests, Bayesian Inference
3. **Discrete Probability Distributions**
    1. Expected value and Variance of a Discrete Random Variable,
    2. Cumulative-Distribution Function of a Discrete Random Variable, Permutations and Combinations,
    3. Binomial Distribution,
    4. Poisson Distribution
4. **Continuous Probability Distributions**
    1. Normal Distribution,
    2. Properties of the Standard Normal Distribution,
    3. Normal Distribution Applications,
    4. Estimation of the Mean and Variance of a Distribution
5. **Sampling Distributions**
    1. Central Limit Theorem
6. **Hypothesis Testing**
    1. Hypothesis Testing (z-test t-test (one and two sample),
    2. chi-squared test),
    3. Analysis of Variance (ANOVA)(one-way & two-way),
    4. Regression analysis
7. **Statistical Software**
    1. Make appropriate use of statistical software (STATA, SPSS, MS- EXCEL etc.).

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Bernard Rosner, "Fundamentals of Biostatistics", 7th Edition, Brooks/Cole Cengage Learning.
2. Wayne W. Daniel, "Biostatistics: A Foundation for Analysis in the Health Sciences", 10th Edition, John Wiley & Sons, Inc
3. SPSS survival manual a step by step guide to data analysis using SPSS 4th edition by Julie Pallant.

(BM-313) - Biomaterials

Course Outline:

Theory

1. **Course Overview and Introduction**
    1. Introduction to biomaterials science
    2. Brief history of biomaterials (generations of biomaterials)
    3. Today's biomaterials applications: overview of types of implantable biomaterials and devices
2. **Properties of Biomaterials: General Concepts**
    1. Bonding, interatomic, intermolecular, surface interactions
    2. Introduction to bulk properties: microstructure, strength, deformation, thermal and optical properties
    3. Techniques: Introduction to surface Characterization of Biomaterials
    4. Electron spectroscopy for chemical analysis
    5. Attenuated total internal reflectance Fourier transform-infrared spectroscopy.
    6. Composite biomaterials
    7. 3D structure of biomaterials by bio X-ray diffraction, application of chitosan and other biopolymers in biomedical
3. **Classes of Materials Used in Medicine**
    1. Polymeric biomaterials (chitosan, collagen, elastin, proteoglycan and glycoperotein)
    2. basic principles: molecular and chemical structure, molecular weight and polydispersity
    3. physical behavior
    4. synthesis: addition, free-radical, condensation polymerization
    5. Hydrogels: structure and synthesis
    6. examples of biomedical hydrogels: acrylic, PVA, PEG, degradable, smart hydrogels
    7. Biological materials: structure and properties, hard tissues: tooth and bone, soft tissues: skin, blood vessel, tendon.
4. **Introduction to Mechanical Properties of Biomaterials**
    1. Review of static and dynamic properties: tensile, compressive, flexural, torsional, viscoelasticity, creep, dynamic modulus
    2. Deformation and fracture of engineering materials
    3. Biomechanics of arthroplasty
    4. Introduction to finite element analysis.
5. **Biomaterials Degradation in the Biological Environment**
    1. Review of clinical cases of implant failure
    2. Mechanisms of metallic corrosion
    3. Fatigue failure
    4. Wear
    5. Polymer degradation
    6. Ceramic degradation
6. **Biocompatibility**
    1. Biological responses to biomaterials
    2. Toxicity and hypersensitivity
    3. Blood-material interactions
    4. Tumours associated with biomaterials and implants
    5. Biofilms
7. **Special Considerations for Implants, Devices and Biomaterials**
    1. Sterility and patient safety
    2. Device Failure Mode Analysis/Risk Analysis
    3. Voluntary consensus standards and regulatory compliance
    4. Legal aspects of biomaterials, clinical trials and case studies in regulations
8. **Tissue Engineering, gene therapy using viral vector materials for scaffolding.**
9. **Biomaterial implantation and Acute inflammation**

10. **Wound healing and the presence of biomaterials**
11. **Immune response to biomaterials**
12. **Biomaterials and thrombosis**
13. **Infection, tumorogenesis and calcification of biomaterials**

List of Practicals:

1. To build molecular model of a biopolymer from basic repeating peptide units
2. Molecular graphics of basic repeating units of biopolymer
3. Interpretation of bio X-ray diffraction of a biomaterial expected diffraction pattern
4. Calculate R-value for structural analysis of biopolymers
5. To build model of CHITOSAN (bio-materials) from basic repeating units.
6. Molecular graphics of basic repeating units of CHITOSAN.
7. Demonstration of features of dental chair & dental operatory.
8. Demonstration of bio-materials (bioceramics, porcelain & metals) its composition & properties
9. Demonstration of the process of sterilization, autoclave & X-ray unit (dental).
10. Separation of bio-material (protein) by electrophoresis method involved in various diseases.
11. Demonstration of different types of sutures.
12. Fabricate a biomaterial for bone tissue
13. Fabricate a biomaterial for dental tissues
14. Tension and compression analysis for fabricated biomaterials.
15. Open ended lab 1
16. Open ended lab 2

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Recommended Texts and Reference Books:

1. Buddy D. Ratner, et al, Biomaterials Science, Second Edition: An Introduction to Materials in Medicine
2. Handbook of Biomaterial Properties (*Second Edition) edited by William Murphy, Jonathan Black, Garth Hastings.
3. Michael N. Helmus (Editor), Biomaterials in the Design and Reliability of Medical Devices
4. David Hill, Design Engineering of Biomaterials for Medical Devices
5. Jos Vander Sloten (Editor), Computer Technology in Biomaterials Science and Engineering (Biomaterials Science & Engineering)
6. Kay C. Dee, et al, An Introduction to Tissue-Biomaterial Interactions
7. Joon B. Park, Joseph D. Bronzino, Biomaterials Principles and Application
8. Xian, Wujing, A laboratory course in biomaterials, 2009.
9. Mahapatro, Anil, Polymers for biomedical applications, 2008.

10. Temenoff, J. S, Biomaterials: The intersection of biology & materials science, 2008.

(BM-401) - Numerical Methods for Biomedical Engineers

Course Outline:

Theory:

1. **Error analysis**
    1. Floating points
    2. Errors and types of errors
2. **Solution of non-linear equation**
    1. Bisection,
    2. Regula-Falsi,
    3. Fixed-point iterative and Newton-Raphson's methods.
    4. Solution of linear algebraic equations.
3. **Direct methods**
    1. Crout's and Cholescky methods;
4. **Iterative methods**
    1. Jaccobi's and Guass-Seidal methods.
5. **Eigen values and eigen vectors**
    1. Characteristics equation and Power methods.
6. **Interpolations and extrapolations**
    1. Forward, backward, central difference operators and their relations.
    2. Newtons Forward, Backward and Divided Difference Interpolation Formulae.
    3. Lagrange's and Stirling's Interpolation Formulae.
7. **Numerical differentiation**
    1. Newton's-Forward and Backward differentiation Formulae.
8. **Numerical quadrature**
    1. Trapezoidal, Simpson's one-third, Simpson's three-eight and Weddle's rules and Gaussian quaderature.
9. **Solution of OD Eqns**
    1. Taylor Series, Euler's and its modified,
    2. Runge-Kutta, Miline's,
    3. Adam-Moltan (Predictor-Corrector) methods.
10. **Solution of Higher Order Differential Equations**
    1. Runge-Kutta methods.
    2. Solution of Partial Differential Equations by Finite Differences Methods (Explicit, Implicit and Crank-Niclson techniques) and ADI Method.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Dunn, Stanley M, Alkis Conastantinides, Numerical Methods in Biomedical Engineering 2006

2. Canal and Chapra “Numerical Methods for Engineers”.
3. Curits F. Gerald “Applied Numerical Analysis”.
4. Erwin Kreyszig “Advanced Engineering Mathematics”.
5. Chung Yau Lam “Applied Numerical Methods for the Solution of Partial Differential Equations”
6. Dr Saeed Akhtar Bhatti “A First Course in Numerical Analysis”.
7. John L. Van Iwaarden “Ordinary Differential Equations with Numerical Techniques”.

(BM-404) - Biomechanics

Course Outline:

Theory:

1. **Introduction**
    1. Definition and perspective
    2. Review of statics
    3. Review of Dynamics
    4. Review of deformable body mechanics
    5. Viscoelasticity, material properties
2. **Anthropometry**
    1. Density, mass and inertial properties
    2. Direct measurement of anthropometric parameters
    3. Muscle anthropometry
    4. Mechanical advantage of muscle
    5. Multipoint muscles,
3. **Kinematics of Human Movement**
    1. Forms of motion
    2. Standard reference systems and joint movement terminology
    3. Spatial reference systems
    4. qualitative vs. quantitative analysis of human movement
    5. limb-segment angles, joint angle, linear and angular velocities and acceleration
    6. tools for direct/indirect measurement of kinematic quantities
4. **The biomechanics of Human Bone Growth and Development**
    1. Composition and Structure of Bone Tissue
    2. Material Constituents
    3. Structural Organization
    4. Types of Bones
    5. Bone Growth and Development
    6. Longitudinal Growth
    7. Circumferential Growth
    8. Adult Bone Development
    9. Bone Response to Stress
    10. Bone Modeling and Remodeling
    11. Bone Hypertrophy
    12. Bone Atrophy
    13. Osteoporosis
5. **Kinetics of Human Movement**
    1. Link segment models
    2. Joint reaction forces
    3. Direct Force measurements
6. **Biomechanics of upper & lower extremity**
    1. Loading and injuries to the shoulder, elbow, wrist joints.
    2. Loading and injuries to the Hip, knee and ankle joints
7. **Gait Biomechanics**
    1. Methods of gait analysis
    2. Gait cycle
    3. Temporal-spatial parameters
    4. Hip, knee and ankle joint kinematics and kinetics
    5. Interpretation of gait data

List of Practicals:

1. To determine the coordinates of the centre of gravity (COG) of a body using segmentation method.
2. To determine the centre of Gravity Measurement using Reaction Board
3. Volumetric analysis of irregular shaped body segments
4. To determine the muscle force required by the biceps while holding a known weight in hand for a range of elbow joint angles using the mechanical arm model
5. To determine the muscle force using an analytical model comprising two muscles at the elbow joint and compare the results with the previous one.
6. Design and develop a goniometer for upper limb.
7. Design and develop a goniometer for lower limb.
8. Design and develop a dynamometer for wrist.
9. Gait analysis among healthy individuals.
10. Dynamometry of human foot by virtue of body weight
11. Volumetric analysis of irregular shaped body segments
12. Analysis of human motion using Movement Velocity counter
13. Development of static human model using Visual 3D
14. Study of blood flow using blood vessel models
15. To design the human limbs on Solid works.
16. To analyse the human limbs on ANSYS.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Susan J. Hall, Basic Bio-Mechanics, 6th Ed, 2011.
2. Margareta Nordin, Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System
3. NihatÖzkaya, et al, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation
4. David A. Winter, Biomechanics and Motor Control of Human Movement

(BM-408) - Biomedical Imaging

Course Outline:

Theory:

1. **Digital Image Fundamental**
    1. Image file formats
    2. Elements of Visual Perception
    3. Image Sampling and Quantization
    4. An Introduction to the Mathematical Tools Used in Digital Image Processing
2. **Intensity Transformations and Spatial Filtering**
    1. Basic Intensity Transformation Functions
    2. Histogram Processing
    3. Fundamentals of Spatial Filtering
    4. Smoothing Spatial Filters
    5. Sharpening Spatial Filters
3. **Filtering in the Frequency Domain**
    1. Review of Concept about Fourier in 1D
    2. Fourier Functions of Two Variable
    3. The Basics of Filtering in the Frequency Domain
    4. Image Smoothing Using Frequency Domain Filters
    5. Image Sharpening Using Frequency Domain Filters
4. **Image Restoration and Reconstruction**
    1. Noise Models
    2. Restoration in the Presence of Noise Only-Spatial Filtering
    3. Periodic Noise Reduction by Frequency Domain Filtering
    4. Inverse Filtering, Least Squares Filtering, GM filtering
    5. Image Reconstruction from Projections
5. **Image Segmentation**
    1. Point, Line, and Edge Detection
    2. Thresholding
    3. Region-Based Segmentation
    4. Segmentation Using Morphological Watersheds
    5. The Use of Motion in Segmentation
6. **Image Compression**
    1. Compression Standards
    2. Some Basic Compression Methods (Huffman Coding, Golomb Coding)
7. **X-ray Imaging**
    1. Physics of X-ray
    2. Imaging with X-ray
    3. Radiation dose
    4. Attenuation based X-ray Imaging
    5. X-ray Detection
    6. X-ray Image Quality
    7. Diagnostic Applications of X-ray Imaging
    8. Demonstration of X-rays Equipment
8. **Principles of Computed Tomography**
    1. Introduction to Computed Tomography and Scanners
9. Attenuation Tomography
10. Time of Flight Tomography
11. Reflection Tomography
12. Diffraction Tomography
13. Formulation of Attenuation Computed Tomography
14. Fourier Slice theorem

1. **Magnetic Resonance Imaging**
    1. Physical and physiological principle of Magnetic Resonance Imaging
    2. MR Imaging
    3. Formulation of MRI reconstruction
    4. Functional MRI, BOLD MRI,
    5. Applications of MRI and fMRI
2. **Ultrasound Imaging**
    1. Generation and detection of ultrasound waves
    2. Physical and physiological principles of Ultrasound
    3. Resolution of Ultrasound imaging
    4. Ultrasound Imaging Modalities
    5. Doppler Ultrasound Imaging
    6. Modes of ultrasound image representation
    7. Ultrasound Image Artifacts
3. **Positron Emission Tomography**
    1. Physical and physiological principles of PET
    2. PET Signal Acquisition
    3. PET Image formation
    4. Significance of PET
    5. Applications of PET

List of Practicals:

1. MATLAB: Introduction to MATLAB and image processing toolbox
2. Digital Image Fundamentals: Sampling and quantization, bits per pixel & shades, spatial resolution & image size, Zooming & shrinking images
3. Basic Gray Level transformations: Image Negative, Log transform.
4. Application Of Gamma Correction to enhance image
5. Contrast stretching and thresholding
6. Introduction to image Histogram , Histogram sliding
7. Histogram equalization
8. Enhancement using arithmetic/logic operations
9. Smoothing spatial filters (Mean and Median filters)
10. Sharpening spatial filters (Laplace and Sobel)
11. Un-sharp masking and high-boost filtering Combining Spatial Enhancement methods
12. Review of Fourier transform and convolution theorem, 2D-FT, FT and frequency components of an image
13. Lowpass and Highpass Filters: Ideal filters, Butterworth filters, Gaussian filters. Filters comparison, Unsharp Masking
14. Dilation and erosion
15. Detection of discontinuities, Edge linking and boundary detection, Segmentation by thresholding
16. Object recognition, classification and image compression

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)

- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Bushberg J.T., The Essential Physics of Medical Imaging 3rd Ed.
2. Z. H. Cho, Foundations of Medical Imaging
3. Biomedical Imaging (Principles & Application Engg: Series).
4. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge University Press 978-0-521-86085-7
5. Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University Press.
6. Digital Image Processing by Gonzales, R. C., Prentice Hall, New Jersey.

(BM-423) - Introduction to Robotics

Course Outline:

Theory:

1. **Fundamentals**
    1. What is a Robot?
    2. Classification of Robots.
    3. What is Robotics?
    4. History of Robotics.
    5. Advantages and Disadvantages of Robots.
    6. Robot Components.
    7. Robot Degrees of Freedom.
    8. Robot Joints.
    9. Robot Coordinates.
    10. Robot Reference Frames.
    11. Programming Modes.
    12. Robot Characteristics.
    13. Robot Workspace.
    14. Robot Languages.
    15. Robot Applications.
    16. Other Robots and Applications.
    17. Social Issues.
2. **Robot Kinematics**
    1. Position Analysis.
    2. Robots as Mechanisms.
    3. Matrix Representation.
    4. Homogeneous Transformation Matrices.
    5. Representation of Transformations.
    6. Inverse of Transformation Matrices.
    7. Forward and Inverse Kinematics of Robots.
    8. Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots.
    9. The Inverse Kinematic Solution of Robots.
    10. Inverse Kinematic Programming of Robots.
    11. Degeneracy and Dexterity.
    12. The Fundamental Problem with the Denavit- Hartenberg Representation.
    13. Differential Motions and Velocities.
3. **Differential Relationships**
    1. Jacobian.
    2. Differential Motions of a Frame.
    3. Interpretation of the Differential Change.
    4. Differential Changes between Frames.
    5. Differential Motions of a Robot and Its Hand Frame.
    6. Calculation of the Jacobian.
    7. How to Relate the Jacobian and the Differential Operator.
    8. Inverse Jacobian.
    9. Design Project.
    10. Dynamic Analysis and Forces.
4. **Lagrangian Mechanics**
    1. A Short Overview.
    2. Effective Moments of Inertia.
    3. Dynamic Equations for Multiple-Degree-of-Freedom Robots.
    4. Static Force Analysis of Robots.
    5. Transformation of Forces and Moments between Coordinate Frames.

6. Design Project.

5. **Trajectory Planning**
    1. Path vs. Trajectory
    2. Joint Space vs. Cartesian-Space.
    3. Basics of Trajectory Planning.
    4. Joint space trajectory planning,
    5. Cartesian space trajectories.
6. **Application of Robotic in BME**
    1. Introduction to medical robotics
    2. Mechanisms for medical robots
    3. Sensing for medical robots
    4. Actuators for medical robots
    5. Controls for medical robots
    6. Interfaces for medical robots

List of Practicals:

1. Introduction to the Rhino
2. The Tower of Hanoi
3. Forward Kinematics
4. Inverse Kinematics
5. Image Processing
6. Camera Calibration
7. Object Centroids
8. Camera Calibration
9. Pick and Place 10 Grading
10. Tactile and force sensing 12 Proximity sensing
11. Medical robotics
12. Open ended lab 1
13. Open ended lab 2
14. Open ended lab 3

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Robotics: Everything You Need to Know About Robotics from Beginner to Expert, Peter Mckinnon(Paperback– January 28, 2016)
2. Robotics, Vision and Control: Fundamental Algorithms in MATLAB, 2011
3. Springer Handbook of Robotics, Siciliano, Bruno, Khatib, Oussama, 2008

4. Robotics Modelling, Planning and Control, Siciliano, B.,Sciavicco, L., Villani, L., Oriolo, 2009.
5. Medical Robotics: Minimally Invasive Surgery, Paula Gomes, ISBN:9780857097392, 2012
6. Medical Robotics, Schweikard, Achim, Ernst, Floris, 2015

(BM-425) - Telemedicine

Course Outline:

Theory:

1. **Origins and Development of Telemedicine**
    1. Overview of e-Health, Telehealth and Telemedicine
    2. Technological & non-technological drivers
    3. Benefits and limitations of telemedicine
    4. Telemedicine in developed & underdeveloped nations
2. **Technologies of Telemedicine Systems**
    1. Types of information & transmission
    2. Tele-Consultation and Telemonitoring
    3. Types of Wireless Networks
    4. Communication Protocols, shared variables and network streaming
3. **Telemedicine Applications**
    1. Tele-Radiology
    2. Tele-Dermatology
    3. Tele-Pathology
    4. Tele-cardiology
    5. Tele-Ophthalmology
    6. Tele-Surgery
    7. Tele-psychiatry
    8. Tele-dentistry
    9. Disaster Management
4. **Development and Delivery of Telemedicine Services**
    1. The Strategic Context of Service Development: USA, Australia, the UK and Malaysia
    2. The Evaluation of Pilot Studies
5. **Ethical and Legal Aspects of Telemedicine**
    1. Confidentiality, Patient Rights and Consent
    2. Data Protection and Security
    3. Telemedical Malpractice
    4. Intellectual Property Rights
6. **Future Trends in Healthcare Technology**
    1. Prognostics in Telemedicine
    2. The Aging Population: Home Care for the Elderly
    3. Smart Home Assistive Technologies
    4. Clothing Technology and Healthcare
    5. Haptic Sensing for Practitioners
7. **Introduction to Information Systems**
    1. Basics of Information Systems
    2. Rudiments of Healthcare Information Management System
    3. HIS, Now and future
8. **Data standards, Handling and Processing**
    1. Data representation
    2. Storage Tiers
    3. Data Structure
    4. Flow Charts and Work Process Flow Diagrams
    5. Electronic Health Records (HERs)
    6. Pros & Cons of Paper medical records
    7. Functions and Benefits of EHRs
9. **Subsystems of HIS**
    1. Health Information Systems in Clinical Settings
    2. Laboratory Information Systems

3. Radiology Information Systems
4. Clinical Decision Support Systems (CDSS)
5. Healthcare Financial Management.

10. **Network and Communication**
    1. Medical device networking
    2. DICOM
    3. HL7 standards
    4. HIMSS

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Strategic Information Management in Hospitals: An Introduction to Hospital by Reinhold Haux ISBN:0-378-40356-6
2. Medical Data Management: A Practical Guide ISBN 978-0-387-21773-4
3. Bernard Fong, ACM Fong, CK Li "Telemedicine Technology: Information Technologies in Medicine and Telehealth" 2011 ISBN: 978-0-470-74569-4
4. Norris A. C, "Essentials of Telemedicine & Telecare", 2001 ISBN: 0-471- 53151-0
5. Marlene Maheu, Ace Allen, Pamela Whitten, "E-Health, Telehealth & Telemedicine": A guide to startup and success. ISBN: 0787944203
6. B.S Chowdhry & Faisal Abro, "Telemedicine Modernization & Expansion of Healthcare System". ISBN: 969-86-80-00-4

(BM-432) - Neuroscience and Neural Networks

Course Outline:

Theory:

1. **Introduction to neuroscience**
    1. Nervous system
    2. Sympathetic
    3. Parasympathetic and motor nervous system and their functions
    4. Brain and its functions
    5. Neurons and glia, structure of a neuronal cell, types of glia.
    6. Blood brain barriers.
2. **Neuronal Circuits**
    1. Neuronal circuit in emotional control
    2. Neuronal circuit in reward and addiction
    3. Neuronal regulation of stress
3. **Receptors**
    1. Ionotropic and metabotropic receptors
    2. signal transduction pathways
    3. G-proteins
    4. protein phosphorylation
    5. Signaling to the nucleus
    6. regulation of gene expression
4. **Neurotransmitters**
    1. Excitatory and inhibitory amino acid neurotransmitters
    2. Functions in the brain
    3. Pain pathways in brain
    4. Role of excitatory neurotransmitter in learning and memory
    5. Diseases associated with the malfunctioning of these neurotransmitters
    6. Neuronal degeneration
5. **Catecholamines**
    1. Functions in the brain
    2. Diseases associated with the malfunctioning.
6. **Neural basis of behavioral plasticity**
    1. Human and animal memory
    2. Cellular mechanisms of neural plasticity
7. **Neuroendocrine and motivational systems**
    1. Endocrine systems
    2. Feeding behavior
    3. Stress
8. **Diseases of the nervous system**
    1. Addiction
    2. Depression
    3. Schizophrenia
    4. Epilepsy
    5. Alzheimer
    6. Parkinson
    7. Prion
    8. Motor Neuron Disease
9. **Introduction to Artificial Intelligence**
    1. Foundations of AI
    2. Agents and Environments.
10. Structure of Agents.
11. Problem Solving Agents.

1. **Problem Solving by Searching**
    1. Searching for Solutions.
    2. Uninformed Search Strategies
    3. Informed Search Strategies
12. Informed (Heuristic) Search Strategies:
13. Greedy Best-first Search.
14. A* Search.
15. Heuristic Functions.
    1. **Reasoning and Knowledge Representation**
        1. Introduction to Reasoning and Knowledge Representation.
        2. Propositional Logic.
        3. First order Logic.
        4. Reasoning with Uncertainty & Probabilistic Reasoning
        5. Acting Under Uncertainty.
        6. Bayes' Rule.
    2. **Learning**
        1. Decision Trees
        2. ID3 Algorithm
        3. Statistical Learning.

List of Practicals:

1. To study basics of Artificial Neural Network.
2. To study how a self-organizing map neural network can cluster iris flowers into classes topologically, providing insight into he types of flowers and a useful tool for further analysis.
3. Classification of wine vintage (using GUI) and crabs (through coding) using pattern recognition and classification network in Matlab.
4. Identification and prediction of relationship between independent and dependent variables using regression analysis.
5. Implementation of basic logic operations of ANN
6. To Work on the Command Line of Matlab to build fuzzy logic based application.
7. Study various methods to improve cognitive skills.
8. Study different methods to check memory skills
9. To understand the working of EEGLAB software for the analysis of EEG signals.
10. To study different processing tools available in EEGLAB software for the processing of EEG data.
11. To study about importing channels locations for EEG data using EEGLAB software.
12. To understand the working of SLORETA software for EEG analysis of the deep cortical structures.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Russell S.; Norvig P.; "Artificial intelligence – A Modern Approach", Latest Edition, Prentice Hall.
2. Luger G.F.; Artificial Intelligence – Structures and Strategies for Complex Problem Solving", Latest Edition, Pearson Higher Education.
3. Progress in Neuroscience, Readings from Scientific American, John Wiley.
4. Philip, G. Srauge, Brain Biochemistry and Brain Disorders, Oxford Press.
5. George, J. Siegal, B. W. Agranoff, S. K. fisher , M. D. Uhler, Basic Neurochemistry: Molecular, Cellular and Medical Aspects, Lippincott D. Uhler.
6. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior, 2010.
7. Mark F. Bear, Barry W. Connors & Michael A. Paradiso, Neuroscience: Exploring the brain, 2006

(BM-451) - Bio-Signal Processing

Course Outline:

Theory:

1. **Introduction to Digital Signal Processing**
    1. Analog-to-Digital& Digital-to-Analog Conversion
    2. Digital Signals, Systems, and Difference Equations
    3. Realizations of Digital Systems
2. **Time domain Analysis**
    1. Digital Convolution
    2. Auto and Cross Correlation
3. **Discrete System Stability**
    1. The z-Transforms
    2. Transfer function, pole zero plot, and System Stability
4. **Discrete Time Fourier Transform**
    1. Frequency response of discrete system
    2. Frequency spectra of discrete signals
    3. Discrete Fourier Analysis and Periodic Signal Spectrum
    4. Fast Fourier transform (FFT),
5. **Finite Impulse Response Filter Design**
    1. FIR filter design using window method.
6. **Infinite Impulse Response Filter Design**
    1. IIR filter design using Bilinear Transformation Method
    2. IIR filter design using Pole-Zero placement, and Impulse Invariance methods.
7. **Biomedical Applications**
    1. Detection of Events: ECG rhythm analysis, Maternal Interference in Fetal ECG
    2. EEG wave-shape and wave-complexity: Analysis of event related potentials, coherence analysis, detection of EEG rhythms
    3. PPG wave analysis
    4. Sound wave analysis
    5. EMG Processing ## **List of Practicals:**
8. Impulse and Step Responses
9. Convolution and Correlation
10. Z-transform, Pole-Zero Plot, Stability
11. Frequency response analysis
12. Frequency spectra analysis
13. FIR filter design
14. IIR Filter Design
15. Analysis of Filter behavior
16. Filter simulation
17. PPG Signal Analysis. Signal Peaks. Peak widths. Heart rate. SpO2
18. ECG Waveform Analysis.
19. EEG Processing
20. Feature Extraction from EEG Signals.
21. Sound Processing. Detecting cardiac condition from digital stethoscope
22. Open ended lab 1
23. Open ended lab 2

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Biomedical Signal Analysis, 2nd Ed, Ranagaraj M. Rangayyan, ISBN: 978- 0-470-91139-6, Willey-IEEE Press.
2. Biomedical Signal Analysis: Contemporary methods and Applications, Fabian J, Theis and Anke Meyer, The MIT Press Cambridge, Massachusetts.
3. Biomedical Signal Processing: Principles and Techniques. D. C. Reddy.
4. Fundamentals of Digital Signal Processing. by: Joyce Van de Vegte.
5. Digital Signal Processing: Fundamentals and Applications. by: Li Tan, 2nd Edition.

(BM-452) - Modelling and Simulation for Biomedical Engineers

Course Outline:

Theory:

1. **Introduction**
    1. What is modeling and simulation
    2. Application of Modeling and Simulation in Biomedical Engineering
    3. Types of Models e.g. graphical model, Quantitative models, Multi-scale Models.
    4. Hybrid models and its application in Biomedical Engineering
    5. Conceptual modeling, why, when, where to use the conceptual model.
    6. Conceptual model of cardiorespiratory system Subdivision of Physiology models and combining of basic elements of Conceptual models.
    7. Things necessary before building a model.
    8. One block model and its examples e.g. Heart, muscles, eye etc.
    9. Hierarchical and integrated Model.
2. **Mathematical Models**
    1. Mathematical Models and their importance in biomedical engineering
    2. Mathematical models of Mechanical and Electrical systems.
    3. Electrical and fluidic modeling of the blood flow through the artery.
    4. Elementary Vascular Model and Its Electrical Analog
    5. Electrical modeling of physiological System
    6. Electrode electrolyte interface model
3. **Application of Modeling and Simulation in Physiological System**
    1. Modeling of physiological systems
    2. Examples of Physiological models
    3. Medical imaging and its importance in modeling and Simulation
    4. Importance of modeling and simulation according to new trends and technique
    5. Modeling of human organs using 3D printing
    6. Thermal modeling using Bio heat equations
    7. Factors effecting thermal models
    8. Application of thermal models on physiological System
4. **Software Implementations**
    1. Implementation of Biomedical models using software.

List of Practicals:

1. Introduction to modeling using software
2. Design of conceptual model
3. Modeling of cardiovascular system
4. Simulation of Bio heat equation
5. Modeling and simulation of blood flow
6. Modeling and simulation arterial plaque
7. Modeling heat transfer through skin
8. Modeling of electrical stimulation
9. Modeling of human organs
10. Heat simulation using RF coil and high intensity focused ultrasound
11. Modeling through medical images
12. Simulation of light propagation in the eye
13. Glucose and insulin regulation model.
14. Renal clearance modeling using compartmental model
15. Skin Absorption Model using Ficks's Law
16. Open ended lab 1

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Modeling and simulation in biomedical engineering, Willem Van Meurs.
2. Physiological Modeling: An Introductory Course for Biomedical Engineers , John Enderle
3. Advances in Numerical Heat Transfer, Volume 3, W. J. Minkowycz.
4. Introduction to Modeling in Physiology and Medicine, Claudio Cobelli and Ewart Carson
5. Modeling and Simulation in Medicine, Frank C. Hoppensteadt, Charles S. Peskin,

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(CS-107) - Introduction to Computing

Course Outline:

Theory:

1. **Introduction**
    1. Applications of Computers
    2. Classification of Computers
    3. Advantages and Disadvantages of Computers.
    4. Basic Components of a Computing Machine.
    5. Input and Output Devices
    6. Mass Storage Devices
    7. Ports, Buses and Expansion slots.
    8. Computer Networking Environment
2. **Data Storage**
    1. Data organization.
    2. Data representation in Computers.
    3. Physical and Logical Storage.
    4. Magnetic Storage Devices viz. RAM, ROM, Secondary Storage, Cache.
    5. Optical Storage Devices.
3. **Data Processing**
    1. Data Structures.
    2. Flow Charts.
    3. Process Flow Diagrams
4. **System and Application Programming**
    1. Basics of Operating Systems.
    2. Desktop and Network Operating Systems, Application softwares.
5. **Computer Programming**
    1. Introduction to High Level and Low Level Programming Languages.
    2. Process of Compilation and Interpretation.
    3. Data Types and Declaration.
    4. Header file and Linkage.
    5. Preprocessor Directives.
    6. Variables and Constants.
    7. Basic library functions.
    8. Input and Output Statements.
    9. Termination, Remarks.
    10. Control structures
    11. Repetition and loops.
    12. Arrays and String Operations
    13. Data Filling
    14. Using Graphics Libraries in Python/C++.
6. **Defining an Engineering Problem**
    1. Transforming Data in to Information.
    2. Using Computers to Solve an Engineering Problem.
7. **Object Oriented Programming Basics**
    1. Understanding core concepts
    2. Classes, Implementation of class and Objects.
    3. Objects as physical objects.
    4. Encapsulation.
    5. Directives
    6. Functions and Overloaded Functions
    7. Reference arguments
    8. Abstraction

9. Polymorphism
10. Object as data types constructor
11. Object as function arguments.

8. **User defined data types, Arrays and String Arrays fundamentals**
    1. User defined data types.
    2. Arrays of objects.
    3. Arrays as class Member Data
    4. Strings and String arrays.
9. **Inheritance**
    1. Concept of inheritance.
    2. Derived classes and Base classes.
    3. Derived Class Constructors.
    4. Member Functions
    5. Class hierarchies.
    6. Public and Private inheritance.
10. **Errors and Exceptions**
    1. A systematic, object-oriented approach to handling errors generated by python classes.
    2. Dealing example errors at runtime using Exceptions.
    3. Understanding Exceptional circumstance of Running out of memory
    4. Understanding Exceptional circumstance of Problems opening a file.
11. **Semester Project- Group Activity**

Practical:

1. Working with Windows 8/10 and DOS.
2. Basic Computer Hardware Awareness and Troubleshooting
3. To begin Programming in Python/C++.
4. Preparing your PC for Python/C++.
5. Understanding Shell and IDLE in Python and/or C++ IDE.
6. Making small programs, do compilation, execution and debugging of programs.
7. Implementation of simple control structures.
8. Using Loops
9. Implementation of functions
10. Using user input and presenting output.
11. Arrays, multidimensional arrays
12. Working with strings, string functions.
13. Data Filling in Python/C++.
14. Using Graphics Libraries in Python/C++.
15. Open Ended Lab I
16. Open Ended Lab II

Teaching Methodology:

- Lecturing, Student Engagement
- Quizzes and Assignments, uploading suggested resources on course website.
- Semester Project
-

Suggested Assessment:

Theory (100%)

- Sessional (20%)

- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Brian Williams and Stacey Sawyer, Using Information Technology, Latest Edition, McGraw-Hill, ISBN: 0072260718
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Latest Edition , Prentice Hall, ISBN: 0131856448, ISBN-13: 9780131856448
3. Allen Downey; Think Python: How to Think Like a Computer Scientist; Green Tea Press Needham, Massachusetts.
4. David Beazley and Brian K. Jones, "PYTHON Cookbook"; O'Reilly Atlas.

(CS-430) - Microprocessor Programming and Interfacing

Course Outline:

Theory:

1. **Introduction**
    1. Computer Architecture
    2. Instruction Cycle
    3. Memory Organization.
    4. Memory Address decoding.
    5. Memory Hierarehy.
    6. Interrupts.
    7. Bus Arbitration Schemes.
    8. Programmed I/O.
    9. Interrupt-Driven I/O.
    10. Direct Memory Access.
    11. General Purpose and Special Purpose Processors,
    12. Internal Registers.
    13. Internal Bus Architecture.
    14. Pin Functions.
    15. Addressing Modes
2. **Instruction Set Architecture:**
    1. Data Transfer Instructions.
    2. Arithmetic & Logic Instruction.
    3. Branch (Instruction).
3. **Assembly programming:**
    1. Testing Assembly Directives.
    2. Macros.
    3. Procedures.
    4. Instruction Encoding.
4. **Microcontroller peripherals:**
    1. Bus Cycles,
    2. Reset Circuit
    3. Clock Generation Circuit
    4. Wait States.
    5. Memory Interfacing
    6. Memory Speed Requirements
    7. I/O Interfacing
    8. Programmable Peripheral Interface.
    9. Programmable Interval Timer,
    10. Programmable Interrupt
    11. Controller, Microprocessor System Design,
5. **Microcontroller Architectures:**
    1. MIPS
    2. AVR
    3. x86
    4. ARM

List of Practicals:

1. To demonstrate the hardware of microcontrollers and microprocessor
2. To use Proteus and Multisim simulating software for simulation
3. To use Keilmicro vision software for assembly and c programming
4. To generate List and Hex files

5. To interface and simulate ports of microcontroller (General)
6. To interface and simulate LEDs
7. To interface and simulate seven segments
8. To interface and simulate monochrome LCD
9. To program and perform ADC
10. To program and perform DAC
11. To connect external memory elements with microcontroller
12. To program and perform DC motor interfacing and PWM
13. To program and perform serial communication (RS232)
14. To program and perform parallel communication (RS232)

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Barry B. Brey, The Intel Microprocessor, 8th ed. 2009, ISBN-10: 0135026458
2. Roger L. Tokheim, Schaum's Outline of Theory and Problems of Microprocessor Fundamentals, Graw Hill Co., 1983, ISBN: 9780070649583
3. Douglas. V. Hall, Microprocessor and Interfacing, Programming and Hardware, Mc. Graw Hill Co., 1986
4. Scott Mackenzie, "The 8051 Microcontroller", Prentice Hall, ISBN: 0-13- 780008-8
5. Muhammad Ali Mazidi, PIC Microcontroller and Embedded Systems, Pearson's Prentice Hall, 2008

(CY-106) - Chemistry

Course Outline:

Theory:

1. **Introduction**:
    1. Wave properties of electrons and matter.
    2. Quantum theory of matter at atomic level, atomic structure.
    3. Energy levels, orbital, hydrogen spectrum, bond energy, molecular structure and its rotational and vibration energy.
2. **Chemical Bonding:**
    1. Types of Bonds, Hybridization and Theories of Bonding.
    2. Valence Shell Electron Pair Repulsion Theory and Molecular Orbital Theory.
    3. Physical state of matter.
    4. Gas laws, properties of liquid, surface tension, viscosity, optical activity, dielectric constant, polarization, dipole moment.
    5. Crystal structure.
3. **Chemical Kinetics:**
    1. Rate of reaction.
    2. order of reaction.
    3. First, Second and third order reaction.
    4. factors affecting rate of reaction like Pressure, Temperature, Concentration, Catalyst, Surface Area and Volume.
4. **Electrochemistry:**
    1. oxidation and reduction reactions.
    2. Balancing of redox reaction in acidic and basic medium.
    3. Construction of galvanic cell.
5. **Organic chemistry:**
    1. Introduction and classification of organic compounds.
    2. Saturated and unsaturated hydrocarbons.
    3. Chemistry of Alkanes, Alkynes,Alkenes and Aromatics.
    4. Nucleophilic and Electrophonic substitution Reactions.

Lab Outline:

1. Order of reaction.
2. factors affecting rate of reaction.
3. acid-base titrations.
4. Redox's titrations.
5. preparation of Acidic and Basic buffer solutions and mixture analysis.

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Silberberg Chemistry: The Molecular Nature of Matter and Change. McGraw Hill.
2. John, R. Holum: Elements of General, Organic and Biological Chemistry. John Wiley & Sons ____

(EE-214) - Circuit Theory

Course Outline:

Theory:

1. **Text and Reference Books:**
    1. Differential and integral forms of circuit equations.
    2. Initial voltage on a capacitor.
    3. Initial current in an inductor.
    4. First-order circuits.
    5. Solution of single first order differential equations.
    6. Particular and total solution of second order linear time invariant differential equations.
2. **Matrix Analysis:**
    1. Systematic formulation of network equations.
    2. Loop variable analysis.
    3. State variable analysis.
    4. Formulation of state equations.
    5. Source transformations Duality.
3. **Elementary Time Functions:**
    1. Introduction to singularity functions
    2. The impulse functions and response.
    3. The unit step function and response
    4. The Ramp function and response.
    5. The Exponential function and response.
4. **Exponential Excitation and the Transformed Network:**
    1. Representation of excitations by exponential functions
    2. Single element response.
    3. Forced response with exponential excitation.
    4. Introduction to the transformed network.
    5. Driving point impedance and admittance.
5. **Two Port Network**
    1. Introduction.
    2. Characterization of linear time invariant two-ports by six sets of parameters
    3. Relationship among parameter sets.
    4. Networks Functions and Frequency Response
    5. The concept of complex frequency, transform impedance and transform circuits.
    6. Network functions.
    7. Poles and zeros of network functions.
    8. Restrictions on pole and zero transfer function, magnitude and phase.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Text and Reference Books:

1. Engineering Circuit Analysis by William Hayt, 7th Edition, 2006. ISBN: 978- 0073263182
2. Fundamentals of Electric Circuits by Charles K.Alexander, Matthew N. O. Sadiku. 4th Edition, 2008.ISBN 978-0077263195

(EE-493) - Digital Signal Processing

Course Outline:

Theory:

1. **Introduction**
    1. Overview of Discrete-time Signals and Systems.
    2. Sampling
    3. Aliasing.
    4. Quantization.
    5. Convolution
    6. Correlation.
    7. Properties of Discrete time Signals and Systems.
2. **Discrete Fourier Transform:**
    1. Frequency Domain Sampling.
    2. DFT Properties.
    3. Inverse DFT.
    4. Windowing and DFT Leakage.
    5. Direct Computation of DFT.
3. **Fast Fourier Transform:**
    1. Divide and Conquer.
    2. Radix algorithms.
    3. Inverse FFT.
    4. Applications of FFT.
4. Discrete time systems implementation.
    1. Overview of z-transform.
    2. Structures of Discrete time systems.
    3. Fixed and Floating number types.
    4. Quantization effects.
5. **Design of Digital Filters:**
    1. General Considerations
    2. FIR and IIR Filters.
    3. Techniques of FIR and IIR filter Design.
6. **Multirate Signal Processing:**
    1. Down sampling and Up sampling.
    2. Decimation and Interpolation

List of Practicals:

1. To be familiarize with the MATLAB and SIMULINK.
2. To plot the sinusoidal, exponential and singularity functions
3. To perform the time-shift, time-scaling and time-reversal operations on the signals
4. To compute and plot the impulse response of the system
5. To compute the convolution of LTI Systems
6. To find the Laplace-Transform and inverse Laplace transform of the system
7. To find the transfer function and system stability
8. To plot the signals spectra using Fourier transform
9. To plot the frequency response of the system
10. To design filter using Butterworth & Chebyshev techniques
11. Open ended lab 1
12. Open ended lab 2
13. Open ended lab 3
14. Open ended lab 4
15. Open ended lab 5

16. Open ended lab 6

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Gorden E. Carlson. Signal and Linear System Analysis. John Wiley & Sons, Inc. 2nd Edition. 1992.
2. Oppenheim, Alan V., and A. S. Willsky. Signals and Systems. Prentice Hall, 1982. ISBN: 9780138097318.

(EF-305) - Engineering Economic and Management

Course Outline

Theory

1. **Introduction:**
    1. Basic Concepts and principles of Economics.
    2. Micro- and Macroeconomic theory,
    3. The problem of scarcity.
    4. Basic concepts of Engineering Economy.
    5. Financial effectiveness and non-monetary factors
2. **Economic Environment:**
    1. Consumers and producer goods.
    2. Goods and services,
    3. Demand & Supply concept.
    4. Market Equilibrium.
    5. Elasticity of demand.
    6. Elasticity of Supply.
    7. Measures of Economics worth.
    8. Price-supply-demand-relationship.
    9. Revenue, Cost and profit function.
3. **Elementary Financial Analysis:**
    1. Basic accounting equation.
    2. Development and interpretation of financial statements.
    3. Income Statement, Balance Sheet and Cash Flows.
    4. Working capital management.
    5. Financial Ratio Analysis .
4. **Time Value of Money and Financial Returns:**
    1. Concepts of simple, compound and effective interest rates.
    2. Less often than compounding period and more once a year;
    3. Present Value, Future Value and Annuities concepts.
    4. Uniform gradient and geometric sequence of cash flow.
5. **Depreciation and Taxes:**
    1. Depreciation concept.
    2. Economic life
    3. Methods of depreciation.
    4. Gain (loss) on the disposal of an asset.
    5. Depreciation as a tax shield.
6. **Basic cost concepts and Break Even Analysis:**
    1. Types of costs and cost curves;
    2. Determination of Cost/Revenues.
    3. Numerical and graphical presentations.
    4. Practical applications.
    5. BEA as a management tools for achieving financial/operational efficiency.
7. **Linear Programming:**
    1. Mathematical statement of linear programming problems.
    2. Graphical solutions.
    3. Simplex method.
    4. Duality Problems.
8. **Business Organizations and financial Institutions:**
    1. Type of ownership, single ownership, partnerships, corporation.
    2. Type of stocks and joint stock companies.
    3. Banking and specialized credit institutions.
9. **Project Management:**

1. Integration of Organization Strategy with Projects.
2. Defining the project.
3. Developing a network plan.
4. Managing risk.
5. Reducing project time.
6. Project selection and comparing alternatives techniques scheduling resources.

10. **Introduction to Projection Management and Production Concepts:**
    1. Basic production function,
    2. Stages of production,
    3. Returns to scales,
    4. Production lead time,
    5. Production rate,
    6. Capacity,
    7. Operations,
    8. Planning and control,
    9. Order processing,
    10. Scheduling,
    11. Material requisitions planning,
    12. Line of balance

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Buchbinder Sharon, Introduction to Healthcare Management Latest ed.
2. Alexander Kolker, Management Engineering for Effective Healthcare Delivery: Principles and Applications, 2012
3. Kaluzny, Warner, Warren, Zelman, Management of Health Services
4. Sakharkar Sharon B, Principles of Hospital Administration & Planning, 2009

(FE-119) - Fundamentals of Electrical Engineering

Course Outline:

Theory:

1. **Electrical Elements and Circuits:**
    1. Energy and energy transfer.
    2. Electric Charge.
    3. Electric Current.
    4. Potential difference and voltage.
    5. Electric power and energy
    6. Electric circuit Sources and Elements.
    7. Resistance, Ohm's law.
    8. Inductance.
    9. Capacitance.
    10. Fundamental circuit laws.
    11. Kirhhoff's Laws.
    12. Direct application of fundamental laws to simple resistive networks.
    13. Node voltage and loop current methods.
2. **Steady State AC Circuits:**
    1. An introduction to periodic functions.
    2. RMS or effective Average and maximum values of current and voltage for sinusoidal signal wave forms.
    3. An introduction to phasor method of analysis.
    4. Applications of phasor methods to simple AC circuits.
    5. Power and reactive power.
    6. Maximum power conditions.
3. **Magnetic Circuits and Transformers:**
    1. Magnetic effects of electric current.
    2. Magnetic circuit concepts.
    3. Magnetization curves.
    4. Characteristics of magnetic materials.
    5. Magnetic circuits with AC excitation.
    6. Hysteresis and eddy current losses.
    7. Introduction to transformer.
    8. The Ideal transformer.
4. **Electromechanical Energy Conversion:**
    1. Basic Principles.
    2. Generated voltage.
    3. Electromagnetic Torque.
    4. Introduction of Magnetic Fields.
    5. Alternating Current Generators.
    6. Commutator Action.
    7. DC Machines.
    8. Direct Current Generators.
    9. Electric Motors.
    10. Losses and Efficiency.
    11. Machine Application Consideration.
5. **Sinusoidal Steady State Analysis:**
    1. Network Response to Sinusoidal Driving Functions.
    2. Complex Impedance and Admittance Functions
    3. Development of Concept of Phasors
    4. Power Consideration.
    5. Complex Power.

6. Maximum Power Transfer.
7. Tuned Circuits.
8. Series and Parallel RLC Tuned Circuits.
9. Definition of Quality Factor.

List of Practicals:

1. To determine the voltage of series circuit
2. To determine the voltage of parallel circuit.
3. To determine the current through mesh analysis
4. To determine the voltage across nodes through nodal analysis of the circuit
5. To determine the voltage across nodes through nodal analysis of the circuit
6. To determine the voltage across Resistor in the circuit.
7. To study the filter circuit and response
8. To study the response of an RC circuit when applied with a sudden dc voltage source.
9. To study the response of a Driven RC circuit when applied with a sudden dc voltage source.
10. To Study the response of Parallel Resonant Circuit
11. To study the response of Series Resonant Circuit
12. To study source free RLC circuit and determine its response mathematically and graphically
13. To determine the transient analysis and plot transient analysis of RL circuit using PSpise
14. To determine the transient analysis and plot transient analysis of RLC circuit using PSpise.
15. Determine Natural Response of an RLC circuit.
16. To study source free RL circuit and determine its response mathematically and graphically

Teaching Methodology:

- Lecturing, Student Engagement
- Quizzes and Assignments, uploading suggested resources on course website.
- Semester Project

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Engineering Circuit Analysis by William Hayt, 7th Edition, 2006. ISBN: 978- 0073263182
2. Fundamentals of Electric Circuits by Charles K.Alexander, Matthew N. O. Sadiku. 4th Edition, 2008.ISBN 978-0077263195

(HS-104) - Functional English

Course Outline:

Theory:

1. **Listening:**
    1. Types of Listening (content, critical, selective, active, reflective, empathic etc.).

2. Problems in listening and coping strategies.
3. Listening skills and sub skills.
4. Practice in Listening Vocabulary Development Words easily confused, compound words, prefixes and suffixes, Forming adjectives, descriptive adjectives (personalities).
5. Using synonyms and Antonyms.
6. Homophones.
7. Use of idioms in current language Exposure and practice to develop everyday vocabulary for formal and informal situations

2. **Reading:**
    1. Skimming, scanning, predicting, and anticipating.
    2. Guessing meanings of unfamiliar words from the context, Reading strategies.
    3. Reading practice through variety of reading texts and comprehension exercises.
    4. Beyond reading [speaking and writing outputs)
3. **Writing:**
    1. Making notes.
    2. Social formal letters (elements, style, formatting, organization and structure, types e.g. requests, invitation, thank you, condolence etc)
    3. Short reports (structure, format, and types i.e. informational, event and analytical)
    4. Grammar
    5. Tenses.
    6. Frequency.
    7. Time and quantity expressions
    8. Punctuation, Conditional Sentences.
    9. Active and passive.
    10. Semantic markers.
    11. Phrasal Verbs
4. **Speaking:**
    1. Giving a presentation.
    2. Discussion.
    3. Beginning a discussion
    4. Entering a discussion (at a subsequent stage).
    5. Interrupting a discussion without giving offence.
    6. Changing your stance / point of view in the course of a discussion, Summing up.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Text and Reference Books:

1. Patterns of College Writing (4th Edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press
2. The Mercury Reader. A Custom Publication. Compiled by Norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton.

3. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
4. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.

(HS-105) - Pakistan Studies

Course Outline:

Theory:

1. **Historical and Ideological perspective of Pakistan Movement:**
    1. Two Nation Theory, Definition;
    2. Claim of Muslims of being a separate nation from Hindus, based upon cultural diversity,
2. **Significance:**
    1. Cultural diversity and interests led to the demand of Pakistan.
    2. Lahore resolution.
    3. Creation of Pakistan.
    4. Factors leading to the creation of Pakistan.
    5. Quaid-e-Azam and the demand of Pakistan.
3. **Land of Pakistan:**
    1. Geo-physical condition.
    2. Geo-political and strategic importance of Pakistan.
    3. Natural resource,
        1. viz: mineral, water and power.
4. **Constitutional Process:**
    1. Early efforts to make a constitution (1947 – 1956) problems and issues,
    2. Salient features of the constitution of 1956 and its abrogation.
    3. Salient features of the constitution of 1962 and its abrogation. Constitutional and political crisis of 1971,
    4. Salient features of the constitution of 1973, Constitutional developments since 1973 to date with special reference to the amendments to the constitutions.
5. **Contemporary issues in Pakistan:**
    1. A brief survey of Pakistan Economy.
    2. An overview of current economic situation in Pakistan: problems, issues and future prospects,
    3. Social Issues,
    4. Pakistani Society and Culture-Broad features.
6. **Citizenship:**
    1. national and international
    2. Literacy and education in Pakistan: problems and issues.
7. **State of Science and Technology in Pakistan:**
    1. A comparison with other countries with special reference to the Muslim world.
    2. Environmental Issues,
    3. Environmental pollution and its hazard: causes, and solutions,
    4. Environmental issues in Pakistan: government policies and measures and suggestions for improvement.
    5. Pakistan's role in the preservation of nature through international conventions / treaties.
    6. Pakistan's Foreign Policies: Evolution of Pakistan foreign policy-1947 to date, A brief survey of Relation with Neighbors, Super Power & the Muslim World.
8. **Human Rights:**
    1. Conceptual foundations of Human Rights.
    2. What are Human Rights? Definition, origins & significance
    3. Comparative analysis of Islamic and Western Perspectives of Human rights
    4. UN System for protection Human Rights.
    5. UN Charter
    6. International Bill of Human Rights
        1. An overview
        2. Implementation mechanism, other important international treaties and conventions.
    7. The convention on the rights of child (CRC)
    8. Convention against torture (CAT),

9. Other treaties and Convention.
10. Pakistan's response to Human Rights at national and international levels, Constitutional Provision

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%) ## **Recommended Text and Reference Books:**

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: A Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
5. Wilcox, Wayne. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e- Islamia, Club Road, nd.
7. Ziring, Lawrence. Enigma of Political Development. Kent England: Wm Dawson & sons Ltd, 1980.
8. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
9. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.

(HS-202) - Business Communication

Course Outline:

Theory:

1. **Essay Writing and 7C's of Communication**
    1. Kinds of Essays
    2. Ways to Develop a Proper Beginning, Middle and Ending of Essay
    3. 7C's of Communication
2. **Use of Library and Internet Resources**
    1. Defining "The Library" and "The Internet"
    2. Researching in the library
    3. Researching on the internet
3. **Correction of Sentences and Question Tags**
    1. General rules of correction
    2. Examples
    3. Uses and Forms of Question Tags
    4. Procedure adding a Question Tag
4. **Précis Writing**
    1. Rules for Précis Writing
    2. Examples
5. **Verbal Communication: Strategies and Activities**
    1. Group Discussions
    2. Brainstorming
    3. Interviewing
    4. Creating a Newscast
6. **Paraphrasing**
    1. Introduction
    2. Uses of Paraphrasing
    3. Characteristics of a good Paraphrase
    4. Method of procedure
    5. Specimens
7. **Report Writing**
    1. Importance of Reports;
    2. Guidelines for Informal Report Writing;
    3. Informal Report Writing Practice sessions
8. **Curricula Vitae:**
    1. Introduction
    2. General Format
    3. Types of CV'
    4. Template for CV
    5. Optional Features
    6. Sample CV
9. **Minutes of Meeting**
    1. Introduction
    2. Meeting minutes Format
    3. Common Problems while taking Minutes of a Meeting
    4. Solution of Problems
    5. Sample Minutes of a Meeting
10. **Writing Memorandum**
    1. Introduction
    2. Audience and Purpose
    3. Format
    4. Sample Memo

11. **Resume Writing**
    1. What is Resume
    2. Kinds of Resume
    3. Role of a Resume
12. **Job Application Materials**
    1. Job Application Letter, Acceptance, Follow-up, and Recommendation Letters
    2. Examples and Practice Sessions
    3. Planning the Resume and Letter
13. **Presentations Skills**
    1. Individual & Group Presentation
    2. Teaching Presentation as a Skill
    3. Project Work on Power Point Presentations

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Exploring The World Of English, Sadat Ali Shah
2. High School English Grammar & Composition P. C. Wren & H. Martin
3. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

(HS-205) - Islamic Studies

Course Outline:

Theory:

1. **Quranic Verses:**
    1. Tauheed: Al-Ambiya – 22, Al – Baqarah - 163&164.
    2. Prophet hood: Al – Imran – 79, Al – Huda – 7, Al- Maida0h-3.
    3. Here-After: Al – Baqarah – 48, and one Hadith.
    4. Basic Islamic Practices: Al – Mu' minun-1-11, and two Ahadith
2. **Amer – Bil – Ma ' Roof Wa-Nahi Anil Munkar:**
    1. the concept of Good & Evil.
    2. Importance and necessity of Da'wat-e-Deen Al- Imran – 110,
    3. Method of Da'wat-e-Deen An-Nehl-125, Al-Imran-104, and two Ahadith.
    4. Unity of the Ummah: Al-Imran-103, Al-Hujurat-10, Al-Imran-64, Al-An'am –108, and two Ahadith.
    5. Kasb-e-Halal: Ta ha-81, Al- A'raf-32-33, Al-Baqarah-188, and two Ahadith.
3. **Haquq-ul-Ibad:**
    1. Protection of life (Al-Maidah-32).
    2. Right to Property (Al-Nisa29).
    3. Right to Respect & Dignity (Al- Hujurat –11-12).
    4. Freedom of Expression (Al-Baqarah-256).
    5. Equality: (Al-Hujurat-13).
    6. Economic Security: 11 (Al-Ma' arij – 24-25).
    7. Employment Opportunity on Merit: (An-Nisa-58).
    8. Access to Justice: (An- Nisa-135).
    9. Women's Rights: An-Nehl-97, Al-Ahzab-35, An-Nisa –07.
    10. Relations with Non-Muslims: Al- Mumtahanah-8-9, Al-Anfa'al – 61 and The last sermon of Hajj of Holy Prophet (PBUH): Relevant extracts.
4. **Seerat (life) of the Holy Prophet (PBUH):**
    1. Birth.
    2. Life at Makkah.
    3. Declaration of prophet hood.
    4. Preaching & its difficulties.
    5. Migration to Madina.
    6. Brotherhood (Mawakhat) & Madina Charter.
    7. The Holy Wars of the Prophet (Ghazwat-e-Nabawi),
5. **Hujjat-ul-Wida, The last sermon of Khutbatulwida:**
    1. Translation and important points
6. **Islamic Civilization:**
    1. a) in the sub continent:
        1. pre- Islamic civilizations.
        2. The political, social & moral impacts of Islamic civilization
    2. b) in the world:
        1. academic, intellectual, social & cultural impact of Islam on the world.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%) ## **Text and Reference Books:**

1. Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
2. Hameed ullah Muhammad, "Muslim Conduct of State"
3. Hameed ullah Muhammad, 'Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,"
5. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication, Islamabad, Pakistan.
6. Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
7. Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
8. H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
9. Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001).

(HS-219) - Professional Ethics

Course Outline:

Theory:

1. **Introduction to Professional & Engineering Ethics:**
    1. Definitions - Ethics, Professional Ethics, Engineering Ethics, Business Ethics;
    2. Ethics & Professionalism.
    3. Need and scope of Engineering and Professional Ethics through case studies;
    4. Development of Engineering Ethics & Major issues in Engineering & Professional Ethics;
2. **Moral Reasoning & Ethical Frameworks:**
    1. Ethical Dilemma;
    2. Resolving Ethical dilemmas and making Moral Choices;
    3. Codes of Ethics (of local and international professional bodies).
3. **Moral Theories:**
    1. Utilitarianism,
    2. Rights Ethics and Duty Ethics, Virtue Ethics Self-Realization & Self Interest;
4. **Ethical Problem Solving Techniques:**
    1. Line drawing, flow Charting, Conflict Problems;
    2. case studies and applications;
5. **Contemporary Professional Ethics:**
    1. Professional Responsibilities;
    2. Risk and Safety as an Ethical Concern for Engineers,
6. **Workplace Responsibilities and Ethics:**
    1. Teamwork.
    2. confidentiality and conflicts of interest,
    3. Whistle blowing,
    4. Bribe and gift,
    5. risk and cost - benefit analyses,
    6. gender discrimination and sexual harassment;
    7. Environmental Ethics;
    8. Honesty;
    9. Truthfulness, trustworthiness, academic and research integrity

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%) ## **Text and Reference Books:**

1. Ferrell, O.C., and Fraedrich, John, Ethical Decision Making and Cases, New York: Houghton Mifflin.
2. Engineering Ethics 4th Edition, by Charles Fleddermann.
3. Engineering Ethics, Outline of an Aspirational Approach, by W. Richard Bowen
4. Theory and Contemporary Issues. Barbara MacKinnon, Andrew Fiala

(MG-481) - Entrepreneurship

Course Outline:

Theory:

1. **Understanding the Entrepreneurship Mind-Set:**
    1. The revolution impact of Entrepreneurship;
    2. The individual Entrepreneurship Mind-set;
    3. Corporate Entrepreneurship Mind-set;
    4. The Social and Ethical perspective of Entrepreneurship.
2. **Conceptualizing Entrepreneurship:**
    1. Definitions and perspective;
    2. Four dimensions of an entrepreneurship venture-individuals, organization, environmental and process.
3. **Formulation of Entrepreneurship:**
    1. The assessment of function with opportunities;
    2. The marketing aspects of new ventures;
    3. Financial statements in new ventures; Business plan preparation for new ventures.
4. **Launching Entrepreneurship Ventures:**
    1. Creativity and innovations;
    2. Methods to initiate ventures;
    3. Legal challenges in Entrepreneurship;
    4. The search for Entrepreneurship.
5. **Strategies perspectives in Entrepreneurship:**
    1. Strategies growth in Entrepreneurship;
    2. Valuation challenges in Entrepreneurship;
    3. Final harvest of a new venture.

Suggested Teaching Methodology:

- Lecturing
- Guest lectures Project
- Written Assignments Report Writing ## **Suggested Assessment:** ### **Theory (100%)**
- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Introduction to Entrepreneurship by Donald F. Kuratko
2. The Entrepreneurial Mindset by McGrath R. G. & McMillan I.

(MT-100) - Introduction To Mathematics (for pre-medical students)

Course Outline:

1. **Algebra**
    1. Complex Numbers
    2. Properties of complex numbers
    3. Conjugates and modulus
    4. Geometrical representation of complex numbers a+ ib.
2. **Quadratic Equations**
    1. Roots of a quadratic equation (real, distinct, equal and imaginary roots)
    2. Formation of quadratic equation when the roots are given
3. **Cube Root of Unity**
    1. Properties of cube root of unity;
4. **Matrices**
    1. Properties, sum, difference and multiplication of matrices
    2. Cramer's rule
    3. Solution of linear equations of three unknowns
5. **Determinants**
    1. Properties: addition, subtraction and multiplication of determinants
    2. Sequence and series
    3. Arithmetic progression
    4. Standard forms of an A. P.
    5. Arithmetic means
    6. Geometric progression
    7. Standard forms of a G. P.,
    8. Sum of Infinite geometric series
    9. Geometric means
    10. Harmonic progression
    11. Harmonic means
    12. Relation between H.M., A.M. and G.M.
6. **Binomial Expansion**
    1. Expansion of type (a+b)n for positive integer of 'n'
    2. Use of the general term and determine the middle term or terms of the expansion.
7. **Partial Fractions**
    1. Resolve into partial fractions
    2. Proper and improper fraction
8. **Functions:**
    1. One-one function
    2. Onto function
    3. Even function
    4. Odd function
    5. Exponential function
    6. Trigonometric function
    7. Logarithmic function
9. **Circular Measure**
    1. Understand the definition of radians and use the relationship between radians and degrees.
10. **Trigonometric Functions**
    1. Basic functions e.g. sine, cosine, tangent etc. relation between them
    2. Trigonometric identities, sum and difference formulae, multiple angle formulae
    3. Express type $a(sin\theta) + b(cos\theta)$ into $Rsin(\theta + -\varphi)$ etc.
    4. Inverse functions
11. **Differential Calculus**

1. Limits: Basic concepts
2. Limit of form $(sin\theta)/\theta$ = I; when θ tends to zero.
3. Exponent functions and type ax etc.

12. **Differentiation**
    1. Differentiation of χn product and quotient formula
    2. Trigonometric, exponents and logarithmic functions
    3. Differentiation of implicit function, parametric function
    4. Higher order Derivatives
    5. Applications of differentiations
    6. Minima and maxima
    7. Tangent and normal velocity and acceleration
    8. Rate of reaction
13. **Integral Calculus**
    1. Basic Integration
    2. Integrals of sum of powers of 'χ'
    3. Trigonometric, exponent and logarithmic functions
    4. Integration by parts: e.g $\chi sin\chi, \chi e\chi and log\chi$ etc.
    5. Substitution method
14. **Coordinate Geometry**
    1. Lines
    2. Find length, mid-point, gradient of line segment, given the coordinates of end points
    3. Different forms of equation of a line
    4. Angle between two lines, distance of a point from a line

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing ## **Suggested Assessment:** ### **Theory (100%)**
- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. FSC Maths Part I /II

(MT-114) - Calculus

Course Outline:

1. **Set and Functions:**
    1. Define rational, irrational and real numbers;
    2. Rounding off a numerical value to specified value to specified number of decimal places or significant figures;
    3. Solving quadratic, and rational inequalities in involving modulus with graphical representation;
    4. Definition of set, set operations, Venn diagrams, DeMorgan's laws, Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions).
    5. Graph of some well-known functions.
    6. Limit of functions and continuous and discontinuous functions with graphical representation.
2. **Differential Calculus:**
    1. Differentiation and Successive differentiation and its application: Leibnitz theorem.
    2. Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series.
    3. Taylor and Maclaurin series, L Hopitals rule, extreme values of a function of one variable using first and second derivative test.
    4. Asymptotes of a function.
    5. Curvature and radius of curvature of a curve.
    6. Partial differentiation.
    7. Exact differential and its application in computing errors.
    8. Extreme values of a function of two variables with and without constraints.
    9. Solution of non-linear equation, using Newton Raphson method.
3. **Integral Calculus**
    1. Indefinite integrals and their computational techniques.
    2. Reduction formulae.
    3. Definite integrals and their convergence.
    4. Beta and Gamma functions and their identities.
    5. Applications of integration.
    6. Centre of pressure and depth of centre of pressure.
4. **Sequence & Series:**
    1. Sequence.
    2. Infinite Series.
    3. Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behavior of series.
5. **Complex Number:**
    1. Argand diagram.
    2. De Moivre formula.
    3. Root of polynomial equations, curve and regions in the complex plane.
    4. Standard functions and their inverses (exponential, circular and Hyperbolic functions).

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing ## **Suggested Assessment:** ### **Theory (100%)**
- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Recommended Text and Reference Books:

1. Advanced Engineering Mathematics, by Erwin Kreyszig, 8th Edition
2. Calculus & Analytical Geometry, Howard Anton. Fifth Edition.
3. Calculus, Thomas & Finney, 1994
4. Calculus And Analytical Geometry, Schaum's Series

(BM-223) - Differential Equations and Fourier Series

Course Outline:

1. **1-st Order Differential Equations:**
    1. Basic concept;
    2. Formation of differential equations and solution of differential equations by direct integration and by separating the variables;
    3. Homogeneous equations and equations reducible to homogeneous from;
    4. Linear differential equations of the order and equations reducible to the linear form;
    5. Bernoulli's equations and orthogonal trajectories; Application in relevant Engineering.
2. **2nd and Higher Orders Equations:**
    1. Special types of IInd order differential equations with constant coefficients and their solutions;
    2. The operator D;
    3. Inverse operator l/D;
    4. Solution of differential by operator D methods;
    5. Special cases, Cauchy's differential equations;
    6. Simultaneous differential equations; simple application of differential equations in relevant Engineering.
3. **Partial Differential Equation:**
    1. Basic concepts and formation of partial differential equations;
    2. Linear homogeneous partial differential equations and relations to ordinary differential equations;
    3. Solution of first order linear and special types of second and higher order differential equations;
    4. D' Alembert's solution of the wave equation and two dimensional wave equations;
    5. Lagrange's solution: Various standard forms.
4. **Laplace Integral & Transformation:**
    1. Definition.
    2. Laplace transforms of some elementary functions.
    3. First translation or shifting theorem.
    4. Second translation or shifting theorem.
    5. Change of scale property.
    6. Laplace transform of the nth order derivative.
    7. Initial and final value theorem.
    8. Laplace transform of integrals.
    9. Laplace transform of functions t^n F(t) and F(t)/ t.
    10. Laplace transform of periodic function.
    11. Evaluation of integrals,
    12. Definition of inverse Laplace transform and inverse transforms.
    13. Convolution theorem.
    14. Solutions of ordinary differential using Laplace transform.
5. **Fourier series:**
    1. Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients;
    2. Expansion of function with arbitrary periods. Odd and even functions and their Fourier series;
    3. Half range expansions of Fourier series, "DFT and FFT, Fourier Spectrum".
6. **Fourier Transform**
    1. Fourier transform of simple functions
    2. Magnitude and phase spectra
    3. Fourier transform theorems
    4. Inverse Fourier transform
    5. Solution of differential equation using Fourier transform

Suggested Teaching Methodology:

- Lecturing

- Written Assignments Report Writing ## **Suggested Assessment:** ### **Theory (100%)**
- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Erwin Kreyszig, Advance Engineering Mathematics, 10th Edition, ISBN: 9780470458365
2. Robert L. Borrelli and Courtney S. Coleman, Differential Equations: A Modeling Perspective, 2nd Edition, ISBN: 9780471433323
3. Dennis G. Zill and Warren S. Wright, Differential Equations with Boundary- Value Problems, 8th Edition, ISBN: 9781111827069
4. Eric W. Hansen, Fourier Transforms: Principles and Applications, 1st Edition, ISBN: 9781118479148
5. J. F. James, A Student's Guide to Fourier Transforms: With Applications in Physics and Engineering, 3rd Edition, ISBN: 9780521176835
6. R. J. Beerends and H. G. ter Morsche, Fourier and Laplace Transforms, 2003, ISBN: 9780521806893

(MT-272) - Linear Algebra And Geometry

Course Outline:

1. **Linear Algebra:**
    1. Linearity and linear dependence of vectors.
    2. Basis Vector.
    3. Dimension of a vector space.
    4. Field matrix and type of matrices (singular, non- singular, symmetric, non- symmetric, upper, lower, diagonal tri-diagonal matrix).
    5. Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix.
    6. Determination of consistency of a system of linear equation using rank, transitions matrix.
2. **Euclidean Spaces and Transformation:**
    1. Geometric representation of vector.
    2. Norm of vector.
    3. Euclidean inner product projections and orthogonal projections.
    4. Euclidean n spaces n properties Cauchy-Schwarz inequality.
    5. Euclidean transformations.
    6. Apply geometric transformations to plane figure composition of transformations.
3. **Application of linear Algebra:**
    1. Leontief Economic models.
    2. Electrical Networks
    3. Scaling, Translation, Rotation, and projection etc.
4. **Eigen values & Eigen Spaces**
    1. Interpret eigenvectors and eigenvalues of a matrix in terms of transformation it represents.
    2. Convert a transformation into a matrix eigen value problem.
    3. Find the eigenvalues and eigenvectors of order not more than 3×3 matrices algebraically.
    4. Determine the modal matrix for a given matrix, reduce a matrix to diagonal (form and Jordan form, state the Cayley-Hamilton theorem and use it to find powers and the inverse of a matrix.
    5. Understand a simple numerical method for finding the eigenvectors of a matrix.
    6. Use appropriate software to compute the eigenvalues and eigenvectors of a matrix.
    7. Define quadratic form and determine its nature using eigenvalues.
5. **Solid Geometry:**
    1. Coordinate Systems in three dimensions.
    2. Direction cosines and ratios, vector equation of a straight line, plane and sphere.
    3. Curve tracing of a function of two and three variables.
    4. Surfaces of revolutions.
    5. Transformations (Cartesian to polar & cylindrical).

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

Text and Reference Books:

1. Howard Anton, Elementary Linear Algebra, 11th Edition, ISBN: 9781118473504
2. Gilbert Strang, Introduction to Linear Algebra, 5th Edition, ISBN: 9780980232776

3. Sheldon Axler, Linear Algebra Done Right, 3rd Edition, ISBN: 9783319110790
4. David C. Lay and Steven R. Lay, Linear Algebra and Its Applications, 5th Edition, ISBN: 9780321982384
5. Bernard Kolman and David Hill, Elementary Linear Algebra with Applications, 9th Edition, ISBN: 9780132296540
6. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, ISBN: 9780470458365

(PH-126) - Physics

Course Outline:

Theory:

1. **Vectors:**
    1. Vectors & vector derivatives.
    2. Gradient of a scalar functions.
    3. Line and surface integrals.
    4. Curl & divergence.
2. **Mechanics:**
    1. Coordinate systems.
    2. Motion under constant acceleration.
    3. Uniform circular motion.
    4. Projectile motion.
    5. Frictional forces.
    6. Fluid friction.
    7. Work and energy principle.
    8. Angular momentum.
3. **Elasticity:**
    1. Stress and strain;
    2. Elastic properties of matter;
    3. physical basis of elasticity;
    4. tension;
    5. compression and sharing;
    6. modulus of rigidity;
    7. relation between three types of elasticity.
4. **Wave, Optics and Laser:**
    1. Standing waves and its analytical treatments;
    2. travelling waves;
    3. interference;
    4. diffraction and polarization phenomenon;
    5. laser;
    6. stimulated emission;
    7. population inversion;
    8. laser applications.
5. **Modern Physics:**
    1. Inadequacy of classical physics:
        1. Black body radiation;
        2. photoelectric effect;
        3. Compton scattering;
    2. De-Broglie wave particle duality hypothesis;
    3. Uncertainty principle;
    4. Quantum physics.
    5. Atomic spectrum:
        1. Atomic spectra;
        2. Bohr theory and hydrogen spectrum; Modification and generalization.
6. **Nuclear physics:**
    1. Properties of nuclear;
    2. nuclear stability;
    3. Alpha, Beta and Gamma decay.
    4. Radioactivity & radioactive equilibrium;
    5. secular equilibrium;
    6. radiation detectors;

7. GM tube;
8. counters and nuclear reactor.

7. **Thermodynamics:**
    1. Closed and open systems;
    2. specific heats;
    3. thermal expansion;
    4. internal energy;
    5. enthalpy and specific heat of ideal gasses;
    6. heat transfer;
    7. energy transfer by work;
    8. mechanism of heat transfer;
    9. Zeroth law, first law; (application for closed and open systems);
    10. second law and third law of thermodynamics; ### **Practical:**
8. Study of Hook's Law
9. Measuring stress, strain and Young's Modulus of different materials
10. Study of Surface Tension and Viscosity of liquids
11. Study of Boiling points of liquids
12. Study of Gas laws
13. Venturi effect of liquids in motion
14. Heat transfer and entropy
15. Study of light, Color addition, Refection and Prism
16. Measurement of Snell's Law
17. Convex and Concave Lens
18. Study of reversibility and Dispersion of Light
19. Focal point and Magnification of Thin lens
20. Focal point and Magnification of Concave Mirror
21. Telescope and Microscope
22. Calculation of speed of Sound

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm(30%)
- Final Term (50%)

Laboratory (100%)

- Labs

Text and Reference Books:

1. David Halliday, Robert Resnick and Jearl Walker, WIE Fundamentals of Physics, 7th ed. 2005, John Wiley & Sons, ISBN:0471465097
2. Arthur Beiser, " Schaum's Outline of Applied Physics, 4th ed. 2004, McGraw-Hill, ISBN:0071426116
3. Hobbie, Russell, Intermediate physics for medicine and biology-4th edition, 2007

(TC-201) - Digital Logic Design

Course Outline:

Theory:

1. **Computer Operations:**
    1. Evaluation of the computer.
    2. Basic organization of digital computer.
    3. Instruction formats.
    4. Different types of computers, special purpose and general purpose computers.
2. **Number Systems:**
    1. Conversion between bases.
    2. Arithmetic with bases other than ten, negative numbers, binary coded decimal numbers, octal, and hexadecimal number systems.
3. **Truth Function:**
    1. Binary connectives.
    2. Evaluation of truth functions.
    3. Many statement compounds.
    4. Physical realizations.
    5. Sufficient sets of connectives.
    6. Digital computer examples.
4. **Boolean Algebra:**
    1. Truth functional calculus as Boolean algebra.
    2. Duality, fundamental theorems of Boolean algebra.
    3. Examples of Boolean simplifications.
    4. Remarks on Switching functions.
5. **Switching Devices:**
    1. Switches and relays logic circuits.
    2. Speed and delays in logic circuits.
    3. integrated logic circuits.
6. **Minimization of Boolean Functions:**
    1. Standard forms of Boolean functions.
    2. Minterm and maxterm.
    3. Designation of Boolean functions.
    4. Karnaugh map representation of Boolean functions.
    5. Simplification of functions on Karnaugh maps.
    6. Map minimization of product of sums expressions.
    7. Incompletely specified functions.
7. **Tabular Minimization:**
    1. Cubical representation of Boolean functions.
    2. Determination of prime implicants.
    3. Selection of an optimum set of prime implicants.
    4. Design of NAND and NOR Networks and properties of combinational network.
    5. Introduction to design of NAND and NOR Networks.
    6. Switching expressions for NAND and NOR Networks.
    7. Transient response of combination Networks.
8. **Introduction to sequential Networks:**

1. Latches.
2. Sequential Networks in fundamental mode.
3. Introduction to the Synthesis of Sequential Networks.
4. Minimization of the number of states.
5. Clocked Networks.

9. **Introduction to Verilog HDL and VHDL Lab work: ## List of Practicals:**
10. Digital Logic Gates
11. Simplification of Boolean Functions
12. Combinational Circuits
13. Code Converters
14. Design with Multiplexers
15. Adders and Subtractors
16. Flip Flops
17. Sequential Circuits
18. Counters
19. Shift Registers
20. Serial Addition
21. Memory Unit
22. Clock Pulse Generator
23. Parallel Adder
24. Binary Multiplier
25. Asynchronous Sequential Circuits ## **Suggested Teaching Methodology:**

- Lecturing
- Written Assignments Report Writing ## **Suggested Assessment:** ### **Theory (100%)**
- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. M. Morris Mano, Digital Logic & Computer Design
2. D. J. Comer, Digital Logic and State Machine Design, Oxford University Press.
3. Victor P. Nelson, et al, Digital Logic Circuit Analysis and Design
4. Brian Holdsworth, Clive Woods, Digital Logic Design, Fourth Edition
5. M. Rafiquzzaman, Fundamentals of Digital Logic and Microcomputer Design, 5th Ed.

6. Tocci, Ronald J, Digital Systems principles and application. 10th Ed, 2009.