FOUNDATION UNIVERSITY ISLAMABAD

فاؤنڈیشن یونیورسٹی اسلام آباد

BS Electrical Engineering
Department of Electrical Engineering (DEE)

Road Map BSEE

Program	No. of semesters	Course Category	No. of courses in program	Credit hours
BSEE	08	Natural Science	7	21
		Humanities	7	16
		Management Sciences	3	8
		Computer and Information	3	10
		Foundation Engineering	9	29
		Core Breath of Engineering	11	42
		Core Depth of Engineering	1	3
		Multidiscipline Engineering	1	1
		Final Year Design Project	2	6
Total			**44**	**136**

Semester Wise Course Plan

Semester-I

Sr.	Course Title	Credit Hours	Status
1.	Functional English	3	Humanities
2.	Calculus and Analytical Geometry	3	Natural Sciences
3.	Linear Circuit Analysis	4	Foundation
4.	Programming Fundamentals	3	Computing
5.	Engineering drawing	1	Foundation
6.	Applied Physics	4	Natural Sciences
	Total	**18**	

Semester-II

Sr.	Course Title	Credit Hours	Status
1.	Differential Equations	3	Natural Sciences
2.	Multi Variable Calculus	3	Natural Sciences
3.	Technical Writing	2	Humanities
4.	Pakistan Studies	2	Humanities
5.	OOP	3	Computing
6.	Occupational Health and Safety	1	Multidisciplinary
7.	Electronic Devices and Circuits	4	Foundation
	Total	**18**	

Semester-III

Sr.	Course Title	Credit Hours	Status
1.	Complex Variables and Transforms	3	Natural Sciences
2.	Professional Ethics	3	Humanities
3.	Digital Logic Design	4	Foundation
4.	Data Structures and Algorithms	4	Computing
5.	Electrical Network Analysis	4	Foundation
	Total	**18**	

Semester-IV

Sr.	Course Title	Credit Hours	Status
1.	Communications and Presentation Skills	3	Humanities
2.	Linear Algebra	3	Natural Sciences
3.	Islamic Studies/Ethics	2	Humanities
4.	Probability methods in Engineering	3	Foundation
5.	Signals and Systems	4	Foundation
6.	Entrepreneurship	3	Management Sciences
	Total	**18**	

Semester-V

Sr.	Course Title	Credit Hours	Status
1.	Electrical Machines	4	Breadth
2.	Instrumentation and Measurement	3	Breadth
3.	Communications Systems	4	Breadth
4.	Operational Behavior	3	Management Sciences
5.	Robotics / Engineering Mechanics	3	Depth
6.	Civic and Community Engagement	1	Humanities
	Total	**18**	

Semester-VI

Sr.	Course Title	Credit Hours	Status
1.	Electrical Workshop Practice	1	Foundation
2.	Linear Control Systems	4	Breadth
3.	Power Distribution & Utilization	4	Breadth
4.	Electronic Circuit Design	4	Breadth
5.	Power Electronics	4	Breadth
	Total	**17**	

Semester-VII

Sr.	Course Title	Credit Hours	Status
1.	Electromagnetic Field Theory	3	Breadth
2.	Digital Signal Processing	4	Breadth
3.	Embedded Systems	4	Foundation
4.	Computer Communication Networks	3	Breadth
5.	Final Year Design Project-I	3	Senior Design Project
	Total	**17**	

Semester-VIII

Sr.	Course Title	Credit Hours	Status
1.	Engineering Economics	3	Management Sciences
2.	Power System Analysis & Protection	3	Breadth
3.	Wireless & Mobile Communication	3	Breadth
4.	Final Year Design Project-II	3	Senior Design Project
	Total	**12**	

12.1 Engineering Domain:

Computer and Information Sciences Courses

Applied Computing Technologies

1. **Introduction to Computer:** Overview of Hardware and Software, Operating systems, Internet and World Wide Web, Software Technologies, How Big is Big Data?

2. **Introduction to Computer Networks**: Basic concepts of computer networks, Network topologies and architectures, Transmission media and protocols, Overview of the OSI model and its layers, Introduction to TCP/IP protocol suite, Network addressing and subnetting.

3. **Basic computer and network organization**: Introduction to operating systems. Introduction to word processing, spreadsheets and presentation softwares. Introduction to mathematical software such as MATLAB. Program, languages, and compilation process Development of flowchart and corresponding pseudo codes. Introduction to simple program coding, executing and debugging involving input / output.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Readings (Latest Edition)

- Paul Deitel, Harvey Deitel , "Intro to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and The Cloud" 1st Edition, Pearson Education, Inc. 2021
- Wes McKinney, "Python for Data Analysis", O'Reilly Media, Inc, 2018
- Peter Norton's Introduction to Computers
- Brookshear, J. Glenn, and Dennis Brylow. Computer Science: An Overview. 13th ed., Pearson, 2022.
- Cormen, Thomas H., et al. Introduction to Algorithms. 3rd ed., MIT Press, 2009.
- Garcia-Molina, Hector, Jeffrey D. Ullman, and Jennifer Widom. Database Systems: The Complete Book. 2nd ed., Pearson, 2008.
- Kurose, James F., and Keith W. Ross. Computer Networking: A Top-Down Approach. 7th ed., Pearson, 2017.
- Silberschatz, Abraham, et al. Operating System Concepts. 10th ed., Wiley, 2018.
- Russell, Stuart, and Peter Norvig. Artificial Intelligence: A Modern Approach. 4th ed.,

Pearson, 2020.

- Scott, Michael L. Programming Language Pragmatics. 4th ed., Morgan Kaufmann Publishers, 2016.
- Hughes, John F., et al. Computer Graphics: Principles and Practice. 3rd ed., Addison-Wesley Professional, 2013.

Computer Programming

Course outline:

- Introduction to problem solving
- Brief review of Von-Neumann architecture,
- Introduction to programming,
- Role of compiler and linker, Introduction to algorithms
- Basic data types and variables
- Input/output constructs
- Arithmetic, comparison and logical operators,
- Conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements
- Lists and their memory organization, multi-dimensional lists,
- Introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, arrays, pointers/references, static and dynamic memory allocation, File I/O operations.
- Recursion and Searching Algorithms
- Sorting Algorithms
- Graphs and Graph Algorithms
- Trees and Binary Search Trees
- Exception Handling and Debugging
- **Programming language**: C/C++/ Java/ Python.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Suggested Books:

- Starting out with Python, 4th Edition, Tony Gaddis.
- Starting out with Programming Logic & Design, 4th Edition, Tony Gaddis,
- The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
- Object Oriented Programming in C++ by Robert Lafore
- Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition by Guttag, John
- Practice of Computing Using Python, 3rd Edition by William Punch & Richard Enbody
- C How to Program, 7th Edition by Paul Deitel& Harvey Deitel
- Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly& Elliot Koffman

Data Structures and Algorithms

Course outline:

- Introduction to Data Structures and Algorithms: Overview of data structures and algorithms, Basic concepts of complexity analysis, Notations and asymptotic analysis.
- Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms
- Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays,
- Hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection.
- Dynamic Programming: Introduction to dynamic programming, Memoization and tabulation techniques, Applications of dynamic programming, Introduction to greedy algorithms, Greedy algorithms and optimization problems, Applications of greedy algorithms, Introduction to searching algorithms, Linear search, binary search, Time complexity analysis of searching algorithms

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Suggested Books:

- Data Structures and Algorithms in C++ by Adam Drozdek
- Data Structures and Algorithm Analysis in Java by Mark A. Weiss
- Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
- Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
- Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

Engineering Foundation Courses

Electrical Work shop

Course Outline

Workshop safety
- Demonstration of safety equipment
- Tools and safety gear in accordance to safety regulations
- Electric shock treatment.

Measurements
- Measurement of bolt using Vernier calipers, micrometer and thread pitch gauge
- Familiarization with different bench fitting tools and equipment

Preparation of Work Piece
- Preparation of work pieces of required dimensions and joining of metal work pieces in lap, butt and T-joints using electric arc welding

Introduction to Lathe Machine and Working on Switches
- Introduction to a lathe machine, its parts, accessories and operations
- Familiarization with the types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc., comprehending their symbols for electrical wiring schematics

Assembling & Earthing Concepts
- Assembling a parallel electric wiring circuit for a hotel and its testing in accordance with wiring regulations.
- Demonstration of earthing concepts and installation of an earthing cable
- Assembling and disassembling of a computer system and preparation of mini report.

Introduction to circuit & PCB Printing
- Introduction to circuit designing and simulation using Proteus
- Introduction to PCB printing (Fabrication of a PCB) and etching in PCB design.
- Demonstration and evaluation of a complete PCB design and fabrication

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Umesh Rathore and Naresh Kumar Sharma, "A Textbook of Electrical Workshop Practices", S.K. Kataria & Sons, 1st Ed. 2019
- S. K. Choudhury, "Elements of Workshop Technology", Vol. 1, Media Promoters & Publishers.
- Chapman, "Workshop Technology", Part-I, II, III, CBS

Linear Circuit Analysis

Course Outline:

Basic Electrical Concepts
- Charge, Current, Voltage, Power
- Voltage and Current sources

Voltage and Current Laws
- Ohm's Law
- Kirchhoff's Current Law
- Kirchhoff's Voltage Law
- Voltage Division in Series
- Current Division in Parallel
- Series and Parallel Sources

Nodal and Mesh Analysis
- Nodal Analysis and Super Node
- Mesh Analysis and Super Mesh
- Comparison between Nodal and Mesh Analysis

Circuit Analysis Techniques
- Linearity and Superposition
- Source Transformation
- Thevenin's and Norton's Theorems
- Maximum Power Transfer
- Delta-Wye Transformation

Energy Storing Elements
- The Inductor
- The Capacitor
- Physical construction and Mathematical Model

First Order Circuits (RL and RC)
- Transient Response
- Steady State Response

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Engineering Circuit Analysis by W. H. Hayt & J. E. Kemmerly 7th Edition
- Basic Engineering Circuit Analysis by J. DAVID IRWIN
- Electric circuit fundamentals by Franco
- Introductory circuit analysis by Robert L. Boylestad

Electric Network Analysis

Course Outline:

Basic RL and RC Circuits
- Source-Free RL and RC circuits
- Unit Step Function
- Driven RL and RC circuits
- Natural and Forced Response

The RLC Circuit
- Source-Free Parallel Circuit
- RLC circuits with DC and AC excitation
- Overdamped Parallel Circuit
- Critical Damping
- Underdamped Parallel Circuit
- Source-Free Series Circuit
- Complete Response of RLC Circuit
- Lossless LC Circuit
- Series and Parallel resonance in AC circuits
- Q-Factor
- Analog Filters

Sinusoidal Steady-State Analysis
- Characteristics of Sinusoids
- Forced Response to Sinusoids Functions
- Phasor Diagrams and introduction to phasor representation of alternating voltage and current
- Impedance and Admittance
- Nodal and Mesh Analysis
- Superposition, Source Transformations and Thevenin's Theorem

AC Circuit Power Analysis
- Instantaneous Power
- Average Power, Apparent Power and Power Factor
- Effective Values of Current and Voltage
- Complex Power

Polyphase Circuits
- Polyphase Systems
- Single-Phase Three-Wire Systems
- Three-Phase Y-Y Connection
- The Delta Connection
- Power Measurement in Three-Phase Systems

Magnetically Coupled Circuits
- Mutual Inductance
- Linear Transformer
- Ideal Transformer

Complex Frequency and Laplace Transform
- Complex Frequency
- Two-port networks and their interconnections
- Laplace Transforms and Inverse Laplace Transforms
- Application of Laplace transform in circuit analysis

Circuit Analysis in s-Domain
- Impedance and Admittance in s-Domain
- Nodal and Mesh Analysis in s-Domain
- Transfer Functions

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Engineering Circuit Analysis by W. H. Hayt & J. E. Kemmerly
- Introductory circuit analysis by Robert L. Boylestad
- S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition)
- V.V. Burg, "Network Analysis", (Latest Edition)
- J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
- Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGrawHill, 7th Edition, 2007.

Digital Logic Design

Course Outline:

Binary Systems
- Introduction
- Number Systems and Conversions
- Arithmetic with number systems
- Signed and unsigned number systems and their arithmetic Binary Codes

Boolean Algebra & Logic Gates
- Boolean Postulates & Theorems
- Boolean Functions and their Complements
- Sum of Min Terms & Product of Max Terms
- Standard forms & Canonical Forms
- Digital logic gates

Combinational Logic
- Analysis and Design
- Code Converters
- Adders & its types
- Subtractors, Multiplier
- Magnitude Comparator
- Decoders and Encoders
- Multiplexers
- Combinational Logic using Verilog simulation

Sequential Circuits
- Latches (SR Latch, D Latch)
- Flip Flops (D Flip Flop, JK Flip Flop, T Flip Flop)
- Characteristic Tables, Characteristic Equations.
- Design and Analysis of Clocked Sequential Circuits (State Equations, State Tables,
- State Diagrams)
- Designing Counters

Registers & Counters
- Simple registers
- Registers with parallel Load
- Shift Registers/Serial to parallel Convertors
- Universal Shift Register
- Asynchronous and Synchronous Counters
- Ripple, Binary, BCD, & Johnson Counters
- Verilog for sequential logic

Introduction to Arithmetic Logic Units
• Simple Arithmetic Logic Units (ALU)
• Introduction to FPGA

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

• Morris Mano and Charles R. Kime, "Logic and Computer Design Fundamentals", Prentice Hall. Latest Edition
• M. Morris Mano and Micheal D. Ciletti, "Digital Design with an introduction to the Verilog HDL", Prentice Hall, 5th Edition.
• Tocci and Widmer, "Digital Systems: Principles and Applications". Prentice Hall. Latest Edition

Electromagnetic Field Theory

Course Outline:

Review of Vectors and Coordinate Systems
• Vector algebra
• Coordinate systems and Transformations
• Vector calculus

Static Electric Field
• Coulomb's law and Electric Field
• Gauss' law and Divergence of Electric Flux Density
• Work, Potential, Potential Gradient and Energy in Electrostatic Field
• Current and Current Density, Conductor, Dielectrics, Boundary Conditions, Capacitance
• Laplace's and Poisson's Equations

Steady-State Magnetic Field
• Steady Magnetic Field
• Biot-Savart Law
• Ampere's Law
• Curl of H, Stoke's Theorem
• Magnetic Boundary Conditions
• Magnetic Material and Boundary Conditions
• Magnetic Flux Density
• Vector Magnetic Potential

- Inductance
- Magneto-static fields and materials

Time varying fields
- Faraday's Law
- Displacement Current Density
- Maxwell's Equations in Differential and Integral Form
- Retarded Potential

Reflection
- Reflection from perfect conductors
- Refection from perfect dielectrics

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- J. D. Kraus and Carver, "Electromagnetics", McGraw Hill
- David K. Cheng, "Fundamentals of Engineering Electromagnetics", Addison Wesley.
- William Hayt and John A. Buck, "Engineering Electromagnetics", McGrawHill, ISBN: 0073104639, Latest Edition.
- Sadiku, Matthew N, "Elements of Electromagnetics", Oxford University Press, ISBN: 0195103688, Latest Edition.
- J. D. Kraus, "Electromagnetics", John Wiley & Sons, Latest edition.

Electronic Devices and Circuits

Course Outline:

Semiconductor Theory
- Introduction to Semiconductors.
- Intrinsic and Extrinsic Semiconductors.
- Doping and energy levels.

Diodes
- PN junction/ Biased PN junction.
- V-I Characteristics.
- Load Line and dynamic resistance.
- Diode models.
- Reverse recovery time and temperature effects.
- Diode Equivalent Circuits Transitions, Recovery, Specification, Notations

- Testing of Diode
- Zener Diode, Light Emitting Diodes

Diode Applications
- Load Line Analysis.
- Parallel and Series Configurations.
- Zener Diodes.
- Voltage-Multiplier Circuits
- Half wave and Full wave rectifiers.
- Clippers and Clampers.
- Logic gates.

Bipolar Junction Transistors
- Construction, Limits of Operation, Specification and characteristics.
- Testing, Casing and Terminal Identification of BJTs
- Amplifying action and variation in current gain.
- Common Emitter, Common Collector and Common Base Configurations.
- Power Ratings.

BJT Biasing Circuits
- Fixed Bias, Voltage Divider Bias and Emitter feedback Bias Circuits
- DC load line and operating point
- Biasing circuit design and stabilization
- Miscellaneous Configurations
- Transistor as a switch

BJT Small Signal Analysis
- AC Domain and BJT Modeling
- Common Emitter Amplifier
- Common Base Amplifier
- Common Collector Amplifier
- Amplifier Design and Loading effects
- Two Port Systems and Cascaded Systems
- Darlington and Feedback Pair
- Hybrid Equivalent Model and Hybrid π Model

Field Effect Transistors
- JFET Construction and Operation
- Transfer characteristics and parameters

FET Biasing Circuits
- Fixed Bias, Self-Bias and Voltage divider Bias
- Design of a bias circuit

FET Small Signal Analysis
- JFET/Depletion MOSFET small-signal model
- Common source, common drain and common gate amplifiers
- Loading effects and design of amplifier circuits

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Electronic Devices and Circuits by Theodore F. Bogart, Jr.
- Electronic Devices and Circuit Theory, H. Boylestad and L. Nashelsky, ISBN-10: 0135026490
- Electronic Devices, Thomas L. Floyd, ISBN-10: 0132359235

Engineering Drawing

Manual Drawing
- Introduction to Drawing Tools and Geometrical Construction
- Sheet Layout, Line Types, Sheet Planning and Dimensioning Principles
- Orthographic 1st angle of projection
- Orthographic 3rd angle of projection
- Isometric projection
- Sectional drawing and assembly drawing
- Reading and preparing electrical engineering drawings such as:
    - Wiring Diagram
    - Power System Layout Diagram
    - PCB Drawing

Computer Aided Drawing (CAD)
- Layout, Line Types
- Practice in Lettering, Numbering and Geometrical Construction
- Engineering Curves – I (polygons, arcs, ellipses, parabola, hyperbola)
- Engineering Curves – II (involutes, cycloids, trochoids, spirals)
- Orthographic 1st angle of projection using CAD
- Orthographic 3rd angle of projection using CAD
- Design of 2-D Indoor Concealed Electrical Wiring Layout of a given Residential or Commercial Building using CAD
- Design of 2-D Outdoor Electrical Underground Wiring Layout of a given Outdoor area or housing society etc. using CAD
- Design of 2-D Outdoor Electrical Overhead Wiring Layout of a given Outdoor area or housing society etc. using CAD
- Introduction to 3D Modeling

Software
- 2D AutoCAD
- 3D AutoCAD
- Revit

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Suggested Books:

- A. C. Parkinson, "First Year Engineering Drawing".
- James D. Bethune, "Engineering Graphics with AutoCAD"
- Shawna Lockhart, "Tutorial Guide to AutoCAD", Prentice Hall.
- N.D. Bhatt, "Elementary Engineering Drawing

Signals and System

Course Outline:

Fundamental Concepts of Signals & Systems

- Introduction
- Signals and their Classification
- Basic Continuous and Discrete Time Signals
- Sampling theorem and aliasing
- Operations on Signals
- Systems and Classification of Systems
- Interconnections of Systems

Linear Time Invariant Systems

- Response of a Continuous Time LTI System and Convolution Integral
- Properties of Continuous and Discrete Time LTI System
- Response of a Discrete Time LTI System and Convolution Sum
- Eigen function of Continuous and Discrete Time LTI System
- Correlation
- Convolution and Properties of Convolution
- Systems Described by Difference and Differential Equations

Laplace Transform and Continuous Time LTI Systems

- The Laplace Transform
- Laplace Transform of Some Common Signals
- Properties of Laplace Transform
- The Inverse Laplace Transform

- The System Function
- Unilateral Laplace Transform
- Solving Differential Equations by Using Laplace Transform

The Z-Transform and Discrete Time LTI Systems

- The z-Transform
- z-Transform of some Common Signals
- Properties of z-Transform
- The Inverse z-Transform
- The System Function of Discrete Time LTI System
- The Unilateral z-Transform
- Solving Difference Equations by Using z-Transform

Fourier analysis of Continuous Time Signals and Systems

- Fourier Series Representations of Periodic Signals
- The Fourier Transform
- Properties of Continuous time Fourier Transform
- Time and Frequency characterization of signals and systems
- The Frequency Response of Continuous Time LTI Systems
- Filtering and Bandwidth
- Modulation

Fourier analysis of Discrete Time Signals and Systems

- Discrete Fourier Series
- Discrete Time Fourier Transform (DTFT)
- Properties of Discrete Time Fourier Transform
- The Frequency Response of Discrete time LTI Systems
- Discrete Fourier Transform (DFT)
- Properties of Discrete Fourier Transform (DFT)
- Fast Fourier Transform (FFT)

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Alan V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals & Systems", Prentice Hall Ed: Current
- B. P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford, 2004
- M. J. Roberts, "Fundamentals of Signals and Systems", McGraw-Hill, 2007
- S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

- C. L. Phillips, J. M. Parr and E. A. Riskin, "Signals, Systems, and Transforms", 4th Edition, Prentice Hall, 2007.

Probability Methods in Engineering

Course Outline:

Fundamental Concepts of Probability
- Set Operation
- Sample Space
- Events and Probabilities
- Probability Axioms
- Conditional Probability
- Independence
- Bayes' Theorem

Discrete Random Variables
- Probability Mass Function
- Bernoulli, Geometric, Binomial and Poisson Random Variable
- Variance and Standard Deviation

Continuous Random Variables
- CDF of Continuous Random Variables
- Probability density function
- Moments and moment generating function
- Expected Value
- Uniform, Gaussian, Standard Normal Random Variables
- Probability Models
- Error Functions and Q-Functions

Pairs of Random Variables
- Joint CDF
- Joint PMF
- Marginal PMF
- Joint PDF
- Functions of Two Random Variables
- Covariance
- Correlation
- Relation of Eigen values and Eigen vectors of Covariance Matrix
- Orthogonal and Uncorrelated Random Variables
- Bivariate Gaussian Random Variables

Statistical Theory
- Basic statistical concepts
- Samples and sampling distributions

- Law of large numbers
- Parameter estimation
- Hypothesis testing and curve fitting

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Roy D. Yates & David J. Goodman, "Probability and Stochastic Processes", John Wiley and Sons Inc., 2005 Ed: Current
- Alberto Leon-Garcia: Probability and Random Processes for Electrical Engineering. Prentice Hall, Inc. New Jersey, 3rd ed. 2008.
- Peyton Z. Peeble Jr.: Probability, Random Variables and Random Signal Principles. McGraw Hill, 4th ed. 2001.
- Richard L. Scheaffer and James T. McClave: Probability and Statistics for Engineers. Brooks/Cole, 5th ed. 2011.

Breadth Engineering Courses

Communication System

Course Outline:

- Model of a Communication System.
- Time domain and frequency domain description of signals and systems by using Fourier Transform.
- Transmission of signal though a linear system.
- Various modulation techniques. AM and FM.
- Concepts of Sampling and quantization. A/D conversion. PCM. and Delta Modulation
- Digital Modulation Techniques: ASK, PSK, DPSK, QAM
- Introduction to Wireless Mobile System
- Noise: Sources. Spectral Density and Probability Density.
- Performance of Analog and Digital Systems in the presence of Noise.
- Evaluation of Error Probability for different Digital Modulated Signals over Noisy Channel.
- Elements of Information Theory and coding techniques. Shannon's Theorem. Exchange of S/N and Bandwidth

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication Systems", Oxford University Press, Fourth Edition, 2010
- John G. Proakis, Masoud Salehi, " Fundamentals of Communication Systems", Second Edition, Prentice Hall, 2013
- John G. Proakis, Masoud Salehi, "Digital Communications", Fifth Edition, McGraw Hill, 2008

Microprocessors and Interfacing

Course Outline:

Microprocessor Systems

- Bus structure,
- DMA and interrupts,
- Microprocessor Architecture
- Memory and I/O ports
- Addressing modes
- Instruction set
- Microprocessor programming techniques
- Microcontrollers.
- **Memory system design**: CPU read/write timing, RAM and ROM

Interfacing
- Interface requirements,
- Address decoding and interfacing dynamic RAM.
- Serial, Parallel, Programmed and interrupt driven I/O
- Direct memory access and peripheral controllers
- Programmable peripheral interface,
- Universe synchronous/asynchronous receiver/transmitter an programmable interrupt controller,
- Data communication standards

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Embedded Systems: Introduction to Arm® Cortex TM -M Microcontrollers (Volume 1), by Jonathan W. Valvano, 5 th Edition, CreateSpace Independent Publishing Platform, 2012
- Embedded Systems: Real-Time Interfacing to Arm® Cortex TM –M Microcontrollers, by Jonathan W. Valvano, 2nd Edition, Create Space Independent Publishing Platform, 2011

Electrical Machines

Course Outline:

Introduction to Electrical Machinery Principles:
Introduction to magnetic field and circuits, Faraday's and Lenz's law, magnetization curves, characteristics of hard and soft magnetic materials, losses.

Transformers, **DC generators and motors**: P parameters and Equivalent circuits of DC Machines and the relationships between speed, power and torque.

AC motors and generators: Pparameters and equivalent circuits of AC Machines. Rrotating magnetic field, the induced voltage and torque, phasor diagrams and the relationships between speed, power, torque.

Transformers Equivalent circuit and phasor diagrams:
Equivalent circuit of practical transformers, approximate equivalent circuit, and equivalent circuit referred to primary and secondary sides, phasor diagram of ideal and practical transformer without load, phasor diagram of secondary side of practical transformer with unity, lagging and leading power factor, complete phasor diagram of practical transformer.

Transformer Tests:
Open circuit Test and calculations of magnetizing branch parameters, short circuit test and calculation of impedance, efficiency calculations, calculation of maximum efficiency, output for maximum efficiency

Transformer Taps and Voltage regulation:
Transformer taps, Voltage regulation, reasons of voltage drop, voltage regulation under different load conditions, transformer phasor diagrams.

Parallel Operation of Transformer
Conditions, advantages of parallel operation of transformer

Instrument transformer and auto transformer
Instrument transformer and auto transformer

Three phase Transformer:
Overview

DC Generator:
Types of DC generators, equivalent circuit and characteristic equations, separately excited generator, shunt generator, voltage build-up phenomenon, series generator, compounded generator and its type; under compounded, over compounded and flat compounded generator, voltage control in all generators and terminal characteristics of all the generators

DC Motors
Working principle, construction, and operation, important parts of DC motor, different types of DC motors, equivalent circuits and terminal equations, magnetic characteristics of DC machines, terminal characteristics of separately excited and shunt type DC motor. Construction and working of stepper motor, brushless DC motor and switched reluctance motor.

DC series motor, expression for torque, applications, terminal characteristics, six methods for speed control

Armature Reaction:
Concept of magnetic and magnetic neutral axis, placement of carbon brushes, armature reaction and its causes, components of armature reaction, effects of armature reaction, remedies for armature reaction, compensating winding, flux enhancement and brush shifting

Commutation:
Commutation process, commutation time, ideal commutation, poor commutation, effects of poor commutation,
practical difficulties, Ldi/dt effect, interpoles, function of interpoles.

Tests and Losses:
Different types of tests, losses and their formulation, power flow diagram of motor and generator, calculation of maximum efficiency, calculation of losses at different loads

Design of Armature Winding:
Pole pitch, coil pitch, front pitch, commutator pitch, multiplex windings, lap winding, wave winding, design examples of lap winding, developed diagram, sequence diagram, parallel path diagram, characteristics of lap winding, derivation of induced EMF.

Introduction to AC Machines:
Introduction to single phase, two phase and three phase systems, waveforms and equations, phasor and polar representation, balanced and unbalanced poly phase systems, Types of AC motors, Main parts, Stator windings, concentrated winding, distributed winding, full pitched winding, fractional pitched winding, pole formation in AC machines, revolving magnetic field in three phase machines.

Introduction to AC Machines:

Nature of magnetic field, properties of DC, single phase, two phase and three phase fields, phase sequence, Reversal of magnetic field in three phase machines, Speed of revolving magnetic field, conditions to produce RMF, Phase splitting in single phase machines. Analytical proof of revolving magnetic field, and basic mathematical expression for machines.

Induction motor and Hysteresis motor:

Construction, working and principle of Induction motor, development of induced torque in induction motor, types of induction motor, squirrel cage and slip ring induction motor and their merits, demerits and comparison, concept of rotor slip and its expression, concept of rotor frequency and its relationship with slip, equivalent circuit of induction motor, rotor circuit and slip effects, final equivalent circuit. Working and construction of hysteresis motor

Power and Torque Calculations:

Power flow diagram of induction motor, calculation of different losses in an induction motor. Modification of equivalent circuit including R_{conv}, the venin voltage and impedance calculation, calculation of current in rotor circuit, expression of induced torque, torque speed characteristics, variation of torque speed characteristics with rotor resistance and stator frequency

Speed Control of Induction motor

Pole changing method, Line frequency method, voltage control method, V/f control for controlling the speed, Rotor resistance control method and torque speed characteristics for each method, Load torque curves.

Tests on Induction motor

No load test, blocked rotor test, resistance test and calculation of R1, R2, Xm, X1 and X2 using the data of tests.

Synchronous Generator

Basic principle and working, different types of prime movers, salient pole and cylindrical rotors and their comparison, brushless exciters, pilot exciters, application of synchronous generators, Synchronous speed expression, DC excitation and use of permanent magnets.

Control of a synchronous generator

Throttle, control of active power, power frequency characteristics, Modes of operation of synchronous generator, working alone, working in parallel with same SG, and connected to infinite bus bar, house diagram and sharing of power, effect of excitation keeping throttle constant, effect of throttle keeping excitation constant, effect of throttle keeping excitation and power factor constant.

Salient pole synchronous generator:

q and d axis and reactance and their calculations, phasor diagram of salient pole machines, derivation of power and torque expressions, comparison of cylindrical and salient pole synchronous generator, calculation of equivalent circuit parameters and synchronization of alternator with infinite bus bar.

Pulsating torque, synchronous Motor starting issues, starting with reduced frequency, starting as synchronous generator, damper winding, comparison of induction motor and synchronous motor.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Electric Machinery Fundamental, Latest Edition, Stephen J. Chapman, McGraw-Hill International
- Fitzgerald, Kingsley and Umans, "Electric Machinery", McGraw-Hill. (Latest Edition)
- Hindmarsh, "Electrical Machines", McGraw-Hill. (Latest Edition)
- Theodore Wildi "Electrical Machines, Drives, and Power Systems

Linear Control Systems

Introduction to control system
- Introduction to control system and its performance parameters
- Open loop and closed loop control system
- Objectives for analyzing and designing control system

Modeling in the frequency domain
- System models
- Transfer function modeling
- Developing transfer functions using Laplace Transform of Electrical Circuits, translational and rotational mechanical systems
- Demonstrate the transfer function of DC motor

Modelling in the Time domain
- Time-domain modeling
- State variables, state equations and output equations
- State Space representation to model electrical and mechanical systems
- Carry out conversion of a transfer function to state space model
- Carry out conversion of a state space model to transfer function

Reduction of Multiple Sub-Systems
- Block diagram reduction for sub systems
- Different configurations used in reduction
- Signal Flow Graphs
- Mason's rule to simplify signal flow graph to single transfer function

Transient response of a system
- System response using Pole Zero Diagram
- Transient response of first order Systems
- Transient response of Second Order Systems
- Transient response of Under damped second order systems

Stability of Linear System
- Stability of a linear system
- Difference between stability of linear and non-linear systems
- Routh-Hurwitz criterion to check stability of a linear system
- Analyzing the stability of a linear systems
- Analysis of special stability cases

Steady State errors
- Steady State Errors
- Steady State errors for unity feedback systems
- System types based on integrators and analyzing the steady-state error using these types.

Root Locus Techniques
- Root locus
- Rules to sketch root locus and analyze the system stability

Frequency response techniques
- Bode plot and Nyquist plot to sketch frequency response of a system
- Analyzing the system stability using Nyquist criterion of stability

Compensator Design
- Designing Lead-Lag compensators to improve the transient and steady-state error of a system
- Designing a PID controller to improve the transient and steady-state error of a system

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Norman S. Nise, Control Systems Engineering, 6th Ed. 2016.
- Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 13th Ed. 2016.
- K. Ogata, Modern Control Engineering, 5th Ed.

Power Distribution and Utilization

Course Outline:

Introduction to distribution system
- Urban, sub urban and rural distribution system
- Primary, secondary and tertiary voltages,
- Distribution conductors & cables, Kelvin's law
- Radial and ring main systems, application of distribution transformers,
- Estimation of load, load characteristics,
- Calculation of voltage drop and regulation in distribution feeders.
- Substation switchgears and bus bar arrangements

Power Cables
- Cable Construction, Types of Cables, Insulating Materials
- Conducting materials.
- Capacitance of a Cable, Dielectric Power Loss. Thermal Characteristics of Cables,
- Cable Installation

Power Factor
- Disadvantages and causes of low power factor,
- Methods for improvement,
- Application of shunt capacitors in distribution network.

Grounding and Earthing
- Distribution transformer neutral,
- Earthing resistance,
- Earthing practice in L.V. networks,
- Electrical Safety

Batteries and ElectroElectrical Process
- Main types of batteries and their working,
- Battery charging, electroplating, electrolysis and electrometallurgical process.
- Cathodic protection of poles, gas pipes, oil pipes and water structures.

Heating & Welding
- Electric heating, resistance, induction and dielectric heating, electric furnaces,
- Microwave and infrared heating,
- Electric welding, resistance welding and its types.

<u>Fundamentals of Illumination Engineering:</u>
- Basic lighting terminologies and laws of illumination
- Requirements for good lighting,
- Illumination schemes for various situations (street lighting,
- commercial/industrial   lighting, stadium/flood/stage/spot lighting, etc.),
- Types of lamps, their working and relative merit,
- Building lighting design

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Principle of Power System by V.K Mehta, Latest Edition.
- M. L. Anand, "A Textbook of Electrical Power", Latest Edition TuranGonen, "Electrical Power Distribution System", CRC P

Depth Engineering Courses
Power Stream

Power Generation
Course Outline:

Power Stations
- Introduction
- Types of power Station
- Choice of type of Generator, Cost of Electrical Energy

Hydro Electric Stations
- Introduction, Types of Hydro Electric Power Stations,
- Principle of working of a Hydro Electric Plant, Power Station Structure and Layout
- Types of Turbine and their characteristics
- Arrangements and location of Hydro Electric Stations
- Types of Hydro Electric Plants and Dam, Characteristics of Generators
- Costs of Hydro Electric Stations

Steam Power Plants
- Introduction, Main Parts and working of a steam Station
- Plant Layout
- Rankin Cycle and its types
- Types of Boiler and their characteristics
- characteristics of steam turbines
- Design of a steam Power Station
- Steam station auxiliaries
- Cost of Steam Station

Gas Turbines
- Introduction, Main Parts of Gas turbine plant,
- Plant Layout, Principle of Operation,
- Characteristics of Gas Turbine plants,
- Gas Turbine Power Plant operation and Control
- Combined Cycles Cost of Gas Turbine Stations

Nuclear Power Stations
- Introduction, Nuclear Reaction, Main Parts of Nuclear Power Stations,
- Plant Layouts,
- Principle of Nuclear Energy,
- Nuclear reactor and reactor control,
- Types of Power Reactor,
- Comparison of various types of reactor,
- Economics of Nuclear Power Stations.

MHD Generators:
- Gaseous conductors, analysis and design of MHD generator,
- Problems associated with MHD generation, possible configuration.

Introduction to renewable energy generation.
- Renewable energy resources

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- M. V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI Publishers
- M. M. El Wakil, "Power Plant Technology", McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
- Arche W. Culp "Principles of Energy Conversion", Latest Edition.

Power System Analysis

Course Outline:

Introduction
- Structure & Growth of Electrical Power Systems
- Per unit system of calculations,
- One Line Diagram, Impedance & Reactance Diagram,
- Bus Impedance and Admittance Matrices-Formation, Modifications and Importance.

Load Flow Solution
- Scope of Load Flow in Electrical Power System,
- Load Flow Problem Formulation & Solution Methodologies,
- Gauss Siedel, Newton Raphson and Fast Decoupled Method and
- Load Flow Control.

Fault Analysis
- Importance of the Fault Analysis in Electrical Power System
- Faults and their Types,
- Symmetrical Fault Analysis (SFA): SFA using Thevenin's Theorem and Z-bus, Short Circuit MVA,
- Unsymmetrical Fault Analysis (UFA): Symmetrical Components, Sequence Impedances, Sequence Networks of Loaded Generator, Line-to-Ground (L-G) fault, Line-to-Line (L-L) Fault and Line-to-Line-Ground (L-L-G) Fault analysis of unloaded generator and Power system.

Power System Stability
- Stability Problem -Scope and Significance,
- Steady State & Transient Stability,
- Power Flow Relationship for Cylindrical & Salient Pole Machines,
- Derivation of Swing Equation,
- Equal Area Criterion, Solution of Swing Equation, Factors Effecting Stability,
- Use of Digital Computer Methods for the Stability Studies

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Hadi Saadat, "Power System Analysis", McGraw-Hill International Editions.
- Glover and Sharma "Power System Analysis"
- Greinger and William D. Stevensons Jr, " Power System Analysis", McGraw Hill, Latest Ed.
- B. M. Weedy ,B. J. Cory, "Electric Power Systems", John Wiley Latest Ed.

<center>**Electrical Power Transmission**</center>

Course Outline:

- One-line diagram, choice of voltage and choice of AC/DC systems, introduction to HV, EHV and UHV systems. Conductor Types, skin effect, Ferranti effect. Short, medium and long transmission lines
- voltage regulation and line surges. Line Supports, Sag and tension calculation, effect of wind pressure and ice loading, conductor vibration and use of dampers. Insulators and Insulator material, string
- efficiency, corona effect. Introduction to HVDC transmission.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- M. V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI Publishers
- M. M. El Wakil, "Power Plant Technology", McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
- Arche W. Culp "Principles of Energy Conversion", Latest Edition.
- Turan Gonen, "Electrical Power Distribution System", CRC Press.

- M. L. Anand, "A Text Book of Electrical Power", Latest Edition
- Arche W. Culp "Principles of Energy Conversion", Latest Edition.
- Turan Gonen, "Electrical Power Transmission System Engineering - Analysis & Design", John Wiely& Sons.

Power System Protection

Course Outline:

Protective Relays
- Need for protective relaying in power systems,
- Basic attributes of protective relaying, principles and characteristics of protective relaying
- Theory and classification of relays,
- Instrument Transformers, CT burden and accuracy classes.

Over-Current Protection
- Inverse characteristics of Over-current relays (OCR)
- Inverse definite minimum time (IDMT) relays
- Primary and backup protection,
- Relay coordination, application of IDMT relays,
- Direct over-current relays (D-OCR),
- Application of D-OCR, protection of a three phase feeder.

Differential Protection
- Dot convention and CT placement,
- Simple Differential Protection,
- Zone of Protection of the Differential Relay
- Percentage Differential Relay,
- Earth Leakage Protection

Protection of Transformers -
- Transformer faults,
- Differential Protection of a three-winding transformer
- Inrush current and differential protection,
- Bucholz relays
- Over-fluxing in transformer

Protection of Generators
- Faults in stator and rotor windings,
- Protective devices for stator, rotor, and prime mover of a generator
- Abnormal operating conditions (unbalanced loading, over-speeding, loss of excitation and loss of prime mover) and their protection.

Protection of Transmission Lines
- Drawbacks of over-current protection
- Distance protection
- Zones of protection

Fuses and Circuit Breakers
- Fuses Introduction,
- Principle of circuit interruption,
- Circuit Breaker-Types and characteristics
- Ratings of circuit breakers.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Fundamentals of Power System Protection by Y.G. Paithankar and S.R. Bhide
- Protective Relaying; Principles and Applications, by J. Lewis Blackburn, Thomas J. Domin.

Power System Operation & Control

Course Outline:

Power System Operational Planning:
- Introduction & brief overview on steps in Power System Operational Planning.
-

Characteristics of power generation units:
- Thermal Machines Cost Characteristics: input-output curve, incremental curve,
- Specific cost curve, format to represent characteristics curves, how curves are obtained, • Hydel Machines cost curves.

Economic Dispatch (ED):
- Concepts & Mathematical formulation
- solution methodologies,
- ED using Economic dispatch using Equal incremental cost Criteria (EICC) neglecting network loss, and including network loss using B-Coefficients.

Unit commitment (UC):

- Concepts, Constraints
- Mathematical formulation, Solution Methodologies
- Priority List schemes for unit commitment

Hydro Thermal Coordination (HTC)
- Concepts, Constraints, Mathematical formulation
- Scheduling Problems
- HTC Solution using Constant Hydro
- Constant Thermal and Running Hydro Plant at its Maximum Efficiency

Frequency Control
- Power System Control
- Load -frequency Control problem, Generator & load model
- Prime Mover Model

Automatic Generation Control (AGC) Voltage Control (VC)

- Voltage control problem importance and concepts, Problem
- Methods for voltage control.

SCADA
- SCADA System overview, architecture, protocols, and application to power system control.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Power Generation, Operation and Control by Allen J. Wood & Bruce F. Wallenberg , John Wiley & Sons, Inc.

Electrical Machine Design & Maintenance

Course Outline:

Machine Design
- Industrial standardization, national and international standards,
- Codes and testing laboratories, manufacturing and operating systems,
- Design considerations for electrical machines
- Properties and applications of materials for magnetic machine insulation system and its design considerations,
- Thermal time constant
- Cooling systems of transformers and rotating machines, duty cycles, • ratings and temperature-rise
- Mechanical design considerations,
- Specific loading and output equations of power transformer and induction motor,
- Design of transformer or induction motor,
- Introduction to computer aided design (CAD) and computer aided manufacturing (CAM).

Installation, Maintenance and Troubleshooting of Machines:
- Safety precautions,
- Troubleshooting and emergency repairs.
- Installation, commissioning, testing, maintenance, and troubleshooting of:
  (i) power transformers and (ii) induction motors. (iii) AC generators

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- S. Rao, "Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publisher, India, Latest Edition.
- M. G. Say, "Alternating Current Machines", Pitman Publishing Ltd.

High Voltage Engineering

Course Outline:

Introduction:

- Importance of High Voltage in all fields of daily life and medical applications

Breakdown Mechanisms:

- Dielectric strength of solids, liquids and gases,
- Breakdown of solids, liquids and gases (Town send and streamer breakdown, breakdown of unstable states of matter.
- Role of high voltage in production of unstable states of matter

Generation of High Voltages:
- Transformer
- Series and Cascaded transformer connections,
- Bracketing in Transformer and its purpose,
- Series and Parallel Resonant Transformer, Tesla Coil, Transformer with rectifier, Voltage Multiplier Circuits, Walton Multiplier, Deltatron Multiplier
- Electrostatic Voltage Generators (Van de Graff Generator, Sames Generator, Kelvin Water dropper, Whimshurst Machine)

Significance and Methods of Generation of Impulse:
- Introduction to Impulse, Standard Impulse used for testing.
- Construction and working of MARX and Good-Let Generators for impulses.
- Impulse Current Generators.

Measurement of High Voltages:
- Direct & Indirect Measurement of high voltages and its significance in a particular situation.
- Direct Measurement: HV probe, Potential Transformer, Ammeter in series with high resistance, Voltage divider
- Indirect Measurement: Spark gaps, Electrostatic Voltmeters, Electrodynamic Voltmeter, Hall Effect Sensor, Electro Optical Measurements.

Grounding and Earthing in Low and High Voltage Systems
- Basics and importance of grounding in low as well as high voltage devices and systems.
- Touch and step potentials in a HV lab.

Leakage Current in Insulation
- Introduction to leakage current, its types and components
- Methods of measuring and minimizing leakage current**.**

Insulation Materials
- Different types of polymeric & Ceramic Insulation materials and their X-tics w.r.t electrical, mechanical, optical, acoustical and environmental resistance.

High Voltage Testing Techniques
- Destructive, non-destructive, routine, fatigue, quantitative, qualitative, physical and Electrical tests on different insulation materials.
- Health analysis of insulation systems.

Design Planning and Layout of HV Labs
- Classification of HV lab on small, medium and large scale.
- Typical facilities required in a HV lab.
- Designing a lab layout and equipment on customized demand.

HVDC:
- Scope trends technologies and future of HVDC.
- Advantages and issues in HVDC systems. HVDC distribution Systems.

Applications of High Voltage
- Applications of high voltage in medical, research and daily life activities

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- High Voltage Engineering by Y. Kuffel, J. Kuffel and W. S. Zaingi 2nd ed.
- High Voltage Engineering by M.S. Naidu, V. Kamaraju, 4th ed
- High Voltage Engineering by Muhammad Naeem Arbab 1st ed
- High Voltage Engineering by J. R. Lucas 1st ed.

Renewable Energy Systems

Course Outline:

Overview
- Present day fuel use,
- Energy Problems of modern societies,
- Renewable Energy Sources as a solution

Solar Thermal Energy:
- Nature and availability of solar radiation, Low temperature solar energy applications,
- Solar thermal engines and electricity generation,
- Economics Potential and environmental impact.

Solar Photovoltaic
- Historical Background, PV in Silicon, Reducing the cost of crystalline PV cells
- Thin film PV, Other innovative PV technologies
- Electrical characteristics of Silicon PV cells and modules
- PV systems for remote power
- Grid-connected PV systems, Economics of PV Energy Systems
- Environmental Impact and Safel

Fuel Cells
- Thermodynamic principles
- Efficiency of fuel cell factors limiting the performance
- Design, new development in fuel cells
- Possibility of future use in Electric vehicles.

Bio Mas
- Introduction
- Past and present, Bio Mass as a fuel
- Extracting the energy, Agricultural residues
  - Energy crops, Environmental benefits and impacts, Economics,
  - New Technologies, Future Prospects.

Wind Energy:
- Introduction, wind turbine types and terms
- Aerodynamics of wind turbines, Mechanical power
- Wind turbine generators, power and energy from wind turbines
- Wind speed characteristics of a site
- Economics of wind turbine
- Commercial development and wind energy potential.

Tidal Power
- Tidal energy harnessing schemes
- Tidal barrages

Geothermal Energy
- Scope, advantages and issues

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Godfrey Boyle, Renewable Energy and Power for a sustainable future, OUP
- John Twidell, Tony Weir, "Renewable Energy Resources", Second Edition, 2006, Taylor and
  Francis, New York and London
- Aldo V. da Rosa, "Fundamentals of Renewable Energy Processes", Second Edition, 2005, Academic Press.

FACTS and HVDC Transmission

Course Outline:

1. FACTS Concept and General System Consideration
- System Compensation
- Bi-direction Ac voltage converter
- Voltage-Sourced Converters,
- Self- and Line-Commutated Current-Sourced Converters

2. Static Shunt and Series Compensators
- TCR
- TSC
- SVC
- STATCOM
- TSSC
- TCSC
- SSSC

3. Combined Compensators
- Unified Power Flow Controller (UPFC)
- Interline Power Flow Controller (IPFC)

4. HVDC Transmission
- Introduction to HVDC transmission
- Types of HVDC Transmission
- Multi-Level Conversion
- Line-Commutated CSC Transmission
- VSC Transmission
- Multi-Level VSC and CSC Transmission
- Introduction to Multi-terminal HVDC (MTDC) grid

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Narain G. Hingorani, Laszlo Gyugyi. "Understanding FACTS: concepts and technology of flexible AC transmission systems" (latest Edition), IEEE Press Marketing.
- J. Arrillaga, Y.H. Liu, N.R. Watson. Flexible power transmission the HVDC options.

Smart Grid

Course Outline:

Smart grid basics:
- Overview of existing grid, why do we need smart grid,
- Objectives and main features of Smart Grid,
- Current status of smart grid technology
- Future of Smart Grid, advantages and Disadvantages,
- Implementation of smart grid and possible difficulties.

Distributed Generation
- Overview of Distributed Generation,
- New paradigm of power generation, future power grid,
- impact of Distributed Generation on the main power grid,
- Smart Grid and Distributed Generation:
- Advantages and Disadvantages

Analysis Tools
- Challenges for load flow studies,
- Load flow analysis in smart grid environment.

Demand side management
- Introduction, types and tools for demand side management,
- Demand response and its applications,
- Types of loads & their current signatures,
- Smart Meters.

Communication Technology for Smart Grid
- Basics of Data communication technology
- Communication protocols.

SCADA (Supervisor Control and Data Acquisition)
- Power System Monitoring and Control,
- Architecture of SCADA,
- Main features and objectives of SCADA,
- Applications of SCADA

Wide Area Monitoring and Control by Synchro-phasor Technology
- PMUs (Phasor Measurement Units),
- Architecture of WAMCS,
- Applications of WAMCS.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Power System Analysis by Hadi Saadat McGraw-Hill International Editions
- The Smart Grid: Enabling Energy Efficiency and Demand Response by Clark W. Gellings, P.E.
- Synchronized Phasor Measurement Units and their applications by A.G Phadke, J.S Thorp

<center>**Power Electronics**</center>

Course Outline:

I. **Introduction to Power Electronics**
- Overview of power electronics and its applications
- Power electronic systems and components
- Switching devices and their characteristics

II. **AC to DC Converters**
- Single-phase and three-phase rectifiers
- Power factor correction techniques
- DC voltage regulators

III. **DC to DC Converters**
- Buck, boost, and buck-boost converters
- Quasi-resonant and soft-switching converters
- Isolated and non-isolated converters

IV. Inverters and AC to AC Converters
- Single-phase and three-phase inverters
- Pulse width modulation techniques
- Voltage source and current source inverters

V. Applications of Power Electronics
- Renewable energy systems and power electronics
- Electric vehicles and charging systems
- Power electronics in industrial and commercial applications

VI. Power Electronics Design and Analysis
- Power electronics circuit analysis and design
- Simulation and modeling of power electronics circuits
- Design and implementation of power electronics systems

Suggested Books (latest edition):

1. "Power Electronics: Essentials and Applications" by L. Umanand (2020, Wiley)
2. "Power Electronics: Devices, Circuits, and Applications" by M. S. Jamil Asghar (2021, Springer)
3. "Power Electronics: Principles and Applications" by Joseph Vithayathil (2020, Pearson)
4. Power Electronics: Converters, Applications, and Design" by Ned Mohan, Tore M. Undeland, and William P. Robbins (2020, Wiley)
5. "Fundamentals of Power Electronics" by Robert W. Erickson and Dragan Maksimovic (2020, Springer)
    6. "Power Electronics Handbook" by Muhammad H. Rashid (2021, Elsevier)

Artificial Intelligence

Course Outline:

- Introduction to AI & Machine Learning
- Linear Regression, Logistic Regression, Gradient Descent Method
- Polynomial Regression, Regularization
- Classification, Evaluation
- Naive Bayes, Decision Tree
- Neural Networks
- Clustering
- Debugging the ML models
- Search - modeling & algorithms
- Search - algorithms
- Informed Search
- Game Playing
- Propositional Logic
- First Order Predicate Logic
- Constraint Satisfaction
- Conclusion & Future of AI

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Artificial Intelligence: Modern Approach, (3rd & 4th ed.), Stuart Russel and Peter Norvig. http://aima.cs.berkeley.edu/

Instrumentation and Measurements

Course Outline:

Measurements:
- Precision measurements terminologies principles of different measurement techniques;
- Types of Errors

Instruments:
- Measurement of electrical and non-electrical quantities including voltmeters, ammeters, function generators, oscilloscopes;
- Systems for signal processing and signal transmission; modern Instrumentation techniques;
- Static and dynamic responses of instrumentation and signal conditioning;

Data acquisition systems
- Principles of operation, construction and working of different analog and Digital meters,
- Advanced Testing & Measuring instruments recording instruments, signal generators,

Transducers:
- Sensors, Input and output transducers;
- Types of bridges for measurement of resistance, inductance, and capacitance;
- Power and energy meters; high-voltage measurements, PLC systems etc.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Modern Electronic Instrumentation and Measurements Techniques by A.D.Helfrick, W.D.
  Cooper
- Klaas B. Klaassen and Steve Gee, "Electronic Measurement and Instrumentation," 1996,
  Cambridge University Press, ISBN: 0521477298.T
- H Kevin, JamesH, "PC Interfacing and Data Acquisition: Techniques for Measurement,
  Instrumentation and Control," 2000, Newnes, ISBN: 0750646241.

Telecommunication/ Communication Stream
Electronic Circuit Design

Course outline:

I. Introduction to Electronic Circuit Design
- Definition of electronic circuit design
- Overview of analog and digital circuits
- Applications of electronic circuits

II. Circuit Analysis and Design Fundamentals
- Ohm's law and Kirchhoff's laws
- Semiconductor devices and their characteristics
- Circuit analysis techniques
- Amplifier design

III. Filters and Oscillators
- Filter design and analysis
- Passive and active filters
- Oscillator design and analysis
- Frequency stability and phase noise

IV. Printed Circuit Board Layout and Design
- Introduction to PCB design software
- PCB design considerations and guidelines
- Design and layout of PCBs

V. Applications of Electronic Circuits
- Audio and video circuits
- Power supply circuits
- Sensor circuits
- Digital circuits

VI. Emerging Trends in Electronic Circuit Design
- Advanced semiconductor devices and their applications
- Internet of Things (IoT) and its impact on circuit design
- Nanoelectronics and their applications

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Electronic Circuit Design: From Concept to Implementation" by Nihal Kularatna (2017, CRC Press)
- "Practical Electronics for Inventors" by Paul Scherz and Simon Monk (2016, McGraw-Hill Education)
- "Analog Circuit Design: Art, Science, and Personalities" edited by Jim Williams (1991, Butterworth-Heinemann)
- "Circuit Design and Simulation with VHDL" by Volnei A. Pedroni (2020, Wiley)
- "The Art of Electronics" by Paul Horowitz and Winfield Hill (2015, Cambridge University Press)
- "High-Speed Digital Design: A Handbook of Black Magic" by Howard W. Johnson and Martin Graham (1993, Prentice Hall)

<center>**Computer Communication Networks**</center>

Course outline:

Overview of Communication System
- Communication Model, Nodes, Links, Protocol, Network Edge (Client, Server).
- Network Fundamentals, Types of Networks (LAN, MAN, WAN), Network Topologies. (Bus, Star, Tree, Ring, Mesh), Logical versus Physical Topology.
- Network Interface Controller, Repeaters, Hubs, Bridges, Switches, Routers, Gateway.
- Access Networks, Core Networks, Internet, Intranet.
- Concept of Packet, Packet Forwarding/Switching, Store-and-Forward Transmission.
- Transmission Delay, Propagation Delay, Queueing Delay.

Physical Media
- Coaxial (10Base-2, 10Base-5), Coaxial Cable Connectors.
- Ethernet (10Base-T, 100Base-TX, 100Base-T), Twisted-Pair Connectors.
- Fiber Optic (10Base-F, 100Base-FX, 1000Base-LX, 1000Base-SX), Fiber-Optic Connectors.
- Serial (RS-232 and RS-422).

Architecture and Protocols
- Layered Models (TCP/IP, OSI), Encapsulation/Decapsulation

Link Layer
- Services Provided by the Link Layer.
- Error-Detection and -Correction Techniques (Parity Checks, Check summing Methods).
- Multiple Access Links and Protocols.
- Channel Partitioning Protocols (FDM, TDM).
- Random Access Protocols (Slotted ALOHA, Pure ALOHA, CSMA/CD, CSMA/CA).
- Taking-Turns Protocols (Polling Protocol, Token-Passing Protocol).
- Switched Local Area Networks (Collision Domain, ICMP, and ARP).
- Self-learning of Switch Table
- Properties of Link-Layer Switching
- Spanning Tree Protocol (STP)
- Virtual Local Area Networks (VLANs)

Ethernet Framing
- Frame Formats (Ethernet II versus IEEE 802.3)
- Media Access Control (MAC) Addressing
- Frame Forwarding and Filtering (Unicast, Broadcast, Multicast)
- Frame Processing (Source MAC, Destination MAC, Type Field, Data, FCS)

IP Addressing
- IP Packet Header and IP Addressing (Network Part, Host Part).
- Network Address, Broadcast Address, IP Address Classes (A, B, C, D, E), Subnet Mask, VLSM.
- IP Addressing Limitations.
- Dynamic Host Configuration Protocol (DHCP).

Network Layer
- Forwarding and Routing.
- Virtual Circuit and Datagram Networks.
- IP Routing Table, Routing Decision (Preference, Metric).
- Static Routing (Application, Behavior, Limitations).
- Routing Algorithms (Distance-Vector Routing Algorithm, Link-State Routing Algorithm).
- Dijkstra's Algorithm.

Transport Layer Protocols
- Transmission Control Protocol (TCP), TCP Ports, TCP Header, TCP Connection Establishment/Termination, Go-Back-N (GBN), Selective Repeat (SR)
- User Datagram Protocol (UDP), UDP Datagram Format, UDP Forwarding Behavior
- Principles of Congestion Control, TCP Congestion Control (Slow Start, Congestion Avoidance, Fast Recovery)

Application Layer Protocols
- The Web and HTTP, HTTP Message Format, Cookies
- File Transfer: FTP
- Overview of How DNS Works

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Data and Computer Communications - William Stallings (7th ISBN-10: 0131006819 or ISBN-13: 978-0131006812).
- Computer Networking: A Top-Down Approach - James F. Kurose, Keith W. Ross (6th Edition ISBN-10: 0132856204 or ISBN-13: 978-0132856201).
- Computer Networks - Andrew S. Tanenbaum, David J. Wetherall (5th Edition, ISBN-10: 0132126958 or ISBN-13: 978-0132126953).
- Computer Networks and Internets - Douglas E. Comer (6th Edition ISBN-10: 0133587932 or ISBN-13: 978-0133587937).
- Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143852 or ISBN-13: 978-1587143854).
- Cisco CCNA Routing and Switching ICND2 200-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143739 or ISBN-13: 978-1587143731).

Digital Communications

Course outline:

Introduction
- Review of basic concepts such as Hartley's and Shannon's law.
- Signal transmission through linear systems, bandwidth of digital data, binary symmetric channels, binary channels, binary eraser channel and memory less channels.
- Detection of binary signals in white Gaussian noise, maximum likely hood receiver structure, matched filter, inter-symbol interference (ISI), equalization.

Digital Modulation Techniques
- Introduction of binary modulation schemes (FSK, PSK and ASK), FSK transmitter and receiver, bandwidth considerations of FSK, Minimum shift-keying FSK (MSK), binary phase shift keying (BPSK), BPSK transmitter and receiver.
- Bandwidth considerations of BPSK, performance (bandwidth and power) of binary modulation schemes in AWGN channels, differential BPSK, constellation diagrams and eye diagrams.
- M-ary modulation techniques (M-ary PSK, Ma-ary FSK and M-ary ASK) and their performance evaluations in AWGN channels.
- Quadrature amplitude modulation (QAM), 8/16-QAM transmitter and receiver, bandwidth considerations of 8/16-QAM.
- Bandwidth efficient modulation schemes (QPSK and its variants, GMSK etc.)
- Clock recovery, performance comparison of modulation schemes in band-limited channels, probability of error and bit error rate.

- **Coding Techniques**
- Introduction to source coding and channel coding.
- Error control coding techniques, forward error correction coding (hamming code), linear codes, block codes, cyclic codes, convolutional codes and turbo codes, performance of these codes in AWGN channels.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Digital Communications - John Proakis, Masoud Salehi (5th Edition, ISBN-10: 0072957166 or ISBN-13: 978-0072957167)

- Digital Communications: Fundamentals and Applications - Bernard Sklar(2nd Edition, ISBN-10: 0130847887 or ISBN-13: 978-0130847881)
- Digital Communication Techniques: Signal Design and Detection - Marvin K. Simon, Sami M. Hinedi, William C. Lindsey (1st Edition, ISBN-10: 0132006103 or ISBN-13: 978-0132006101)
- Digital and Analog Communication Systems - Leon W. Couch (8th Edition, ISBN-10: 0132915383 or ISBN-13: 978-0132915380)
- Digital Communication Systems - Simon Haykin (1st Edition, ISBN-10: 0471647357 or ISBN-13: 978-0471647355)

Wireless and Mobile Communications

Course outline:

Introduction
- Introduction to wireless communication systems.
- Classification of wireless systems.
- Wireless propagation mechanisms (free space, sky waves and space waves etc.), frequency classifications, radio frequency management.

- **Link Performance**
- Wireless channel and impairments, path loss, path geometry.
- Propagation models, free-space models, frii's equation, two-ray models, diffraction models.
- Fading, small scale fading (due to delay spread and due to doppler spread), large scale fading, rayleigh and rician fading, average duration of fade, level crossing rate, curved earth model, mitigation of fading using equalization, link budget.
- Access techniques (FDMA, TDMA and CDMA etc.), power control, cell splitting, cell breathing, sectoring.

Introduction to Cellular Communication System
- History, evolution of cellular system, six basic components in every cellular system.
- Frequency re-use concept, co-channel interference, channel assignment methods, handover and roaming.
- Multiple access techniques (FDMA, TDMA and CDMA etc.), power control, cell splitting, cell breathing, sectoring.

Spread Spectrum Systems
- Introduction to spread spectrum methods.
- Direct sequence spread spectrum, frequency hopping spread spectrum, slow and fast FHSS.
- Pseudo noise codes, m-sequences, walsh hadamard codes, correlation properties of spreading codes, orthogonal frequency division multiplexing.

Legacy Systems
- Introduction to GSM, system architecture, frame structure and channel types.
- GSM link level, GSM handover and roaming.
- IS-95 (CDMA-based), GPRS/EDGE systems, UMTS, UTRAN, HSPA, long-term evolution (LTE), LTE-A and beyond

Other Wireless Communication Systems
- Diversity techniques (SISO and MIMO systems), cooperative communications, WiMAX, Bluetooth v4/v5, UWB systems, WLAN (IEEE 802.11n)

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- The Mobile Radio Propagation Channel - J. D. Parsons(2nd Edition, ISBN-10: 047198857X or ISBN-13: 978-0471988571)
- Wireless Communications: Principles and Practice - Theodore S. Rappaport(2nd Edition, ISBN-10: 0130422320 or ISBN-13: 007-6092011736)
- Modern Wireless Communications - Simon O. Haykin, Michael Moher(5th Edition,ISBN-10: 0130224723 or ISBN-13: 978-0130224729)

Satellite Communications

Course outline:

Principle of Satellite Communication
- Introduction and historical background and need of satellite communication.
- Uplink and downlink frequencies, international regulation and frequency coordination.
- Satellite frequency allocation and band spectrum, general and technical characteristics of satellite communication signal.

Orbits and Launching Methods
- Introduction to orbits and Kepler's laws for planetary motion, orbital perturbations, GEO-stationary orbit, and antenna look angles, earth eclipse of satellite, launches and launch vehicles.
- Access techniques (FDMA, TDMA and CDMA etc.), power control, cell splitting, cell breathing, sectoring.

Radio Wave Propagation
- Introduction of wave propagation theory.
- Polarization of satellite signals, atmospheric losses, ionospheric effects, rain attenuation and depolarization and other impairments.

The Space and Earth Segments
- Introduction of satellite segments.
- Satellite on board processing and satellite subsystems
- Introduction and types of earth stations.

The Space Links
- Introduction, equivalent isotropic radiated power (EIRP).
- Transmission losses, link power budget calculations, carrier-to-noise ratio (C/N) and carrier to interference ratio (C/I).

Satellite Accessing Techniques
- Introduction of access techniques, pre-assigned and demand assigned FDMA, pre-assigned and demand assigned TDMA, satellite-switched TDMA, code-division multiple access (CDMA).

Satellite Systems and Services
- Introduction of satellite systems and global positioning system (GPS).
- Very small aperture terminals (VSATs), direct broadcast satellite (DBS) services.
- Mobile satellite services, metrological satellite services, remote sensing services.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Satellite Communications - Dennis Roddy (4th Edition, ISBN-10: 0071462988 or ISBN-13: 978-0071462983)
- Satellite Communication Systems - M. Richharia(2nd Edition, ISBN-10: 0071342087 or ISBN-13: 063-9785308706)
- Handbook on Satellite Communications - International Telecommunications Union (3rd Edition, ISBN-10: 0471221899 or ISBN-13: 978-0471221890)
- Satellite Communications Fundamentals - Jules E. Kadish, Thomas W. R. East (1st Edition, ISBN-10: 1580531369 or ISBN-13: 978-1580531368)
- Satellite Communications - Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt (2nd Edition, ISBN-10: 047137007X or ISBN-13: 978-0471370079)

Navigation Systems

Course outline:

Introduction/ Fundamentals
- Conventional navigation, positioning and navigation in this technology-driven society: need, applications and use cases.
- Overview of Global Navigation Satellite System (GNSS), historical perspective, development, evolution and current status of global (GPS GLONASS, Galileo, BeiDou/ COMPASS) and regional navigations satellite systems (IRNSS, QZSS).
- Differential GPS/GNSS
- Principles of Radio Navigation (Reference frames; coordinate transformations; orbital dynamics; time standards)

GNSS System Architecture
- Detailed overview of GNSS architecture including space segment, user segment and control segment.
- GNSS signal structure, codes and frequency bands and navigation message.
- Satellite Constellations, Transmitting Frequency, Satellite geometry and dilution of precision.
- Basic Equations for Finding User Position

GNSS Receiver Design
- Overview of GNSS receiver design, working principle and architecture.
- Types of receivers: Single-constellation receiver, dual-constellation receiver, dual-frequency receiver and multi-constellation & multi-frequency GNSS receivers.
- Signal acquisition and Signal Tracking, tracking loops, Code and carrier phase tracking.
- Signal demodulation, correlation and navigation message decoding.

GNSS Potential Vulnerabilities & Error Sources
- Atmospheric and signal propagation errors i.e., ionospheric delay, tropospheric delay, ionospheric scintillation and space weather effects.
- System errors: satellite orbital errors, receiver noise, clock biases & drifts.
- Environmental errors including fading, multipath and non-line-of-sight (NLOS) signal reception.
- Intentional errors: selective availability, jamming and spoofing.

Navigation Signal Processing and Positioning Estimation
- Pseudo range and carrier phase measurements
- Navigation message extraction and decoding
- Least squares Estimation
- Kalman filtering

GNSS Performance Assessment and Multipath Mitigation
- GNSS Receiver performance assessments: field experimentation, measurement campaigns, signal quality monitoring, integrity and accuracy analysis.
- Multipath mitigation Techniques and Algorithms.

Context-Aware Navigation
- Context-detection, recognition and Adaptive Navigation
- Multipath mitigation using context detection and environment characterization.
- Machine Learning for Precise Navigation.

Teaching Methodology (Proposed as applicable)
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Introduction to Satellite Navigation, Inertial Navigation, and GNSS/INS Integration by Farrell and Barth (ISBN-10: 111844700X or ISBN-13: 978-1118447009).
- "Global Navigation Satellite Systems: Signal, Theory and Applications" by B. Parkinson and J. Spilker Jr. (ISBN-10: 3319979868 or ISBN-13: 978-3319979860).
- "Global Navigation Satellite Systems Receivers: GPS, GLONASS, Galileo, and More" by Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, and Elmar Wasle (ISBN-10: 3211998994 or ISBN-13: 978-3211998991).
- Multi-GNSS Systems and Engineering" by Shuanggen Jin, Esteban Zatoni, and Rosa P. Vargas (ISBN-10: 3319691966 or ISBN-13: 978-3319691965).
- "Position, Navigation, and Timing Technologies in the 21st Century: Integrated Satellite Navigation, Sensor Systems, and Civil Applications" by Michael Braasch and John Raquet (ISBN-10: 1119356351 or ISBN-13: 978-1119356354)

Next Generation Networks (NGN)

Course outline:

Standardization:
- NGN standardization by ITU, fixed and mobile broadband as basis for NGN, NGN architectures, NGN services, QoS and IMS for NGN deployments, VoIP and IPTV services over NGN, Internet of Everything.
- VPN in NGN, IPv6-based NGN, migration scenarios from legacy networks to NGN,
- Business approaches and regulation for NGN, future networks as defined by ITU, including network virtualization, software defined networking, smart ubiquitous networks, big data issues,

- OTT service providers versus Telco service models, impact of M2M in the future, convergence of regulation towards future networks, cloud computing, including ITU's framework,

Architectures
- Cloud ecosystem, architectures and cloud service models, cloud security, OTT cloud services, Telco cloud implementations.
- Mobile cloud computing services and applications, as well as business and regulation aspects for cloud computing

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Valdar, A., "Understanding Telecommunications Networks", latest edition, IET Telecommunications Series. ISBN 9781849197458.
- Wilkinson, N., "Next generation networks services: Technologies and strategies", latest edition, John Wiley & Sons. 196 p. ISBN 0-47148667.
- Ohrtman, F D. "Softswitch Architecture for VoIP", latest edition: McGraw-Hill, 359 p. ISBN 0-071409777.
- Mueller, S M., "APIs and Protocols for Convergent Network Services", latest edition McGraw-Hill, 445 p. ISBN 0-07138880X.
- Hu Hanrahan, "Network Convergence: services, Applications, Transport, and Operations Support", latest edition, John Wiley & Sons. ISBN-13:
- 978-0470024416.

Internet of things (IoT)

Course outline:

Basics of Electronic Designs
- ADCs/DACs, PVM and Voltage Dividers

Basics of Networking
- Understanding the OSI model and the seven abstraction layers.
- Networking and TCP/IP.

SDN Architecture
- Control and Management plane improvements with SDN
- Openness
- Network Automation and Virtualization
- SDN and Open Stack
- ONOS SDN Controllers

- Applications and APIs
- Protocols

Arduino and Raspberry Pi Programming
- Introduction to the Internet of Things
- IoT and its importance
- Elements of an IoT ecosystem
- Technology and business drivers
- IoT applications, trends and implications.

Sensors and sensor nodes
- Sensing components and devices.
- Sensor modules, nodes, motes and systems.

Connectivity and networks
- Wireless technologies for the IoT.
- Edge connectivity and protocols.
- Wireless sensor networks.

IoT lab exercises
- Local processing on the sensor nodes.
- Connecting devices at the edge and to the cloud.
- Processing data offline and in the cloud.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
- Keysight Technologies, The Internet of Things: Enabling Technologies and Solutions for Design and Test, Application Note, 2016.

Wireless Network System
Course Outline

Structure
- Channel structure and signal flow.
- Operation and maintenance features vis-àvis cellular and WLAN/WMAN/WPAN technologies.

Planning
- Wireless network planning process.
- RF environment introduction and propagation model, antenna and feeder system, link budget.
- Capacity theory, site survey, network optimization process.
- Signaling trace, access optimization, handoff optimization, power control optimization, drop call optimization, drive test.

Advanced Tools
- Introduction to advanced tools for network planning, simulation and optimization

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:
Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

Suggested Books (Latest Editions)

- Ghosh, J. Zhang, J. G. Andrews and R. Muhamed, "Fundamentals of LTE", latest Edition, Prentice Hall, ISBN-13: 978-0137033119.
- Y. Xiao and Y. Pan, "Emerging Wireless LANs, Wireless PANs, and Wireless MANS: IEEE 802.11, IEEE 802.15, 802.16 Wireless Standard Family", latest Edition, Wiley, ISBN-13: 978-0471720690.
- D. M. Dobkin, "RF Engineering for Wireless Networks", latest Edition, Newnes, ISBN-13: 978-0750678735.
- J. Wheat, R. Hiser, J. Tucker, A. Neely and A. McCullough, "Designing a Wireless Network: Understanding How Wireless Communication Works", latest Edition, Syngress, ISBN-13: 978-1928994459.

Telecommunications Standards and Regulations

Course Outline:

Introduction
- Basic concepts and definitions
- Selected regulatory terminologies

Pakistan Telecom. Background/Historical Perspective
- Covering telecom sector's background, from the days of T&T to the current competitive scenario prevailing in the local telecom market.
- Introduction to and functioning of telecom regulatory stakeholders in Pakistan: stakeholders, like the GoP (MoIT), pakistan telecom authority (PTA), frequency allocation board (FAB), telecom operators/service providers, telecom consumers, etc.

Telecom Deregulation and Liberalization (A Conceptual Framework)
- Familiarization with Telecom liberalization, privatization, de-regulation, competition etc. as per international best practices.

Regulating for Effective Competition
- Conceptual frame work of telecom regulation as international best practices, prevailing regulatory environment in the country; competition amongst various segments of services in Pakistan and future prospects etc.
- Process of legislation in Pakistan and introduction to telecom policies, act, rules and regulations: process of enactment of legislation/laws,
- Presentation/discussion on telecom reorganization act of 1996, introduction to various telecom rules and major regulations issued by PTA and analysis of their usefulness/utility.

Introduction to Telecom Standards and Protocols
- Familiarization with international/regional telecom organizations/bodies: functioning of various agencies/bodies (international and regional) such as World Bank, WTO, ITU, APT and SAARC etc.
- Acquaintance with telecom standard organizations like ITU (T), IEEE and international organization of standards (ISO) etc.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:
Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

Suggested Books (Latest Editions):
- Section 1 (Chapters 1, 2, 4, 7), Section 4 (Chapters 15, 16), Section 6 (Chapters 24, 26,27,28), Section 7 (Chapter 31) of "The APC ICT Policy Handbook (Second edition) | Association for Progressive Communications", apc.org, 2016. [Online]. Available: https://www.apc.org/en/pubs/books/apc-ictpolicy- handbook-second-edition.
- Chapters 1,2 of "10th Anniversary Telecommunications Regulation Handbook", infodev.org, 2016. [Online]. Available: http://www.infodev.org/articles/10th-anniversary-telecommunications-regulationhandbook.
- Secondary Reading: International Telecom. Union (ITU) relevant publications at www.itu.int ; International Organization for Standardization (ISO) at www.iso.org ; Institute of Electrical & Electronics Engineering (IEEE) at www.ieee.org
- An Introduction to International Telecommunications Law - Charles H. Kennedy, M. Veronica Pastor (1st Edition, ISBN-10: 0890068356 or ISBN-13: 978-0890068359)
- International Telecommunications Handbook - Robert M. Frieden (1st Edition,ISBN-10: 0890065683 or ISBN-13: 978-0890065686)

Network Management (NM)

Course outline:

Architecture
- TNM architecture and functional architecture.
- Physical architecture and information, logical layered architecture,

Management
- TNM relationship with other management approaches.
- Requirements, analysis, and class diagrams, alarm management information object classes.
- Inheritance and relationship between alarm list and information.

Operations
- IRP operations, generic rules, TNM design, eTOM, NGOSS, ITIL,
- Managing next generation networks, ITU-T M.3100 information model, G.803, CMIP, F-interface architecture and SNMP.

Planning
- Packet types and fundamentals of RF planning

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- S. Aidarous and T. Plevyak, "Telecommunications Network Management: Technologies and Implementations", latest Edition, WileyIEEE Press, ISBN: 978-0780334540.
- H-G. Hegering, S. Abeck, B. Neumair, "Integrated Management of Networked Systems: Concepts, Architectures and their Operational Application", latest Edition, Morgan Kaufmann, ISBN: 978-0123911100.

Telecommunications Traffic Engineering

Course outline:

Processes
- Poisson process, Markov processes and birth-death processes.
- Purpose of tele traffic theory, tele traffic models, classical model for telephone traffic, classical model for data traffic.

Telecommunication Networks
- Telecommunication networks, network level - switching and routing,
- Link level - multiplexing and concentration.
- Shared media - multiple access, circuit switched network modeled as a loss network, packet switched network modeled as a queuing network.

Traffic Measurement
- Traffic measurements, traffic variations and traditional modeling of telephone traffic.
- Traditional modeling of data traffic, simple tele traffic model, Poisson model, Erlang model, binomial models and Engset model.
- M/M/1, M/M/n, generation of traffic process realizations,

Data Collection
- Generation of random variable realizations, collection of data and statistical analysis.

Network Planning
- Network planning, traffic forecasts, dimensioning, MPLS traffic management, IP-networks,
- Traffic and congestion control in the Internet and QoS architectures in the Internet.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- T. Viswanathan, "Telecommunication Switching Systems and Networks", latest Edition, Prentice Hall, ISBN: 978-81-203-5083-0.
- J. C. Bellamy, "Digital Telephony", latest Edition, Wiley, ISBN: 978-0471345718.
- Chee Hock Ng, Soong Boon-Hee, "Queueing Modelling Fundamentals: With Applications in Communication Networks", latest Edition, WileyInterscience, ISBN: 9780470519578.
- G. Giabene, "Queuing Theory and Telecommunications: Networks and Applications", latest Edition, Springer, ISBN: 978-1461440833.
- Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris, "Fundamentals of Queueing Theory", latest Edition, Wiley-Interscience, ISBN: 9780471791270.
- Leonard Kleinrock, "Queueing Systems (Volume I): Theory," John Wiley & Sons, latest edition. ISBN: 0471491101.

Optical Communications

Course outline:

Introduction
- History of optical communication.
- Elements of optical fiber communication (OFC) transmission link.
- Evolution of fiber optic system and advantages of OFC system.

Optical Fiber Wave Guides
- Optical fiber waveguide and Ray theory transmission.
- Electromagnetic mode theory for optical propagation and cylindrical fibers
- Single mode fiber and multimode fibers.
- Step index fibers, graded index fibers, single mode/multimode fiber transmission characteristics.

Transmission Characteristics
- Attenuation, absorption losses (intrinsic and extrinsic), scattering losses, fiber bend loss, linear scattering losses (Rayleigh and Mir scattering).
- Non-linear scattering losses (stimulated brillouin and stimulated raman scattering).
- Pulse broadening, intra-modal and inter-modal dispersion.
- Overall fiber dispersion, polarization, non-linear effects.

Optical Fiber Cables and Connectors
- Optical fibers, fiber strength and durability.
- Cable design, fiber-to-fiber joints and fiber splicing.

- **Optical Fiber Communication System**
- Components of fiber optic networks and optical amplifiers.
- Semiconductor optical amplifiers (SOA).
- Erbium doped fiber amplifiers (EDFA).
- Advanced multiplexing strategies, operational principles of wavelength division multiplexing (WDM), FDDI, SONET/SDH networks, wavelength routing networks, wavelength cross-connects, Resilient Packet Ring (RPR) IEEE 802.17.

Passive Optical Networks (PONs)
- PON overview, optical line terminator (OLT), optical network unit (ONU).
- Optical distribution network (ODN), PON evolution (TDM-PONs, WDM-PONs), splitter/couplers configurations, PON standards.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Optical Fiber Communications: Principles and Practice - John Senior (3rd Edition, ISBN-10: 013032681X or ISBN-13: 978-0130326812)
- Optical Fiber Communications - Gerd Keiser (4th Edition, ISBN-10: 0073380717 or ISBN-13: 978-0073380711)
- Understanding Optical Fiber Communications - A. J. Rogers (1st Edition, ISBN-10: 0890064784 or ISBN-13: 978-0890064788)
- Fiber-Optic Communication Systems - Govind P. Agrawal (2nd Edition, ISBN-10: 0471175404 or ISBN-13: 978-0471175407)
- Optical Fiber Communication Systems - Leonid Kazovsky, Alan E. Willner, Sergio Benedetto (1st Edition, ISBN-10: 0890067562 or ISBN-13: 978-0890067567)
- Fiber Optic Networks - Paul E. Green (1st Edition, ISBN-10: 0133194922 or ISBN-13: 978-0133194920)
- Optical Networks: A Practical Perspective - Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki (3rd Edition, ISBN-10: 0123740924 or ISBN-13: 978-0123740922)
- Optical Communication Networks - Biswanath Mukherjee (1st Edition, ISBN-10: 0070444358 or ISBN-13: 978-0070444355)
- Multiwavelength Optical Networks: A Layered Approach - Thomas E. Stern, Krishna Bala (1st Edition, ISBN-10: 020130967X or ISBN-13: 978-0201309676)

Microwave and Radar Systems

Course outline:

Introduction
- Microwave definition, microwave frequencies, properties of microwaves.

Transmission Lines
- General description of waves on transmission line.
- E-waves, h-waves, group velocity, phase velocity, impedance and admittance relationship of transmission line.
- Propagation characteristics (attenuation constant, phase constant), travelling waves and standing waves, VSWR (Voltage Standing Wave Ratio).

Microwave Network Analysis
- Z and Y parameters analysis.
- ABCD and S representation of microwave networks.
- Transmission lines, discontinuities and s-parameters, smith chart analyzing rules, smith chart and matching networks, wave-guide transmission line single mode propagation.

Waveguides and Microwave Antennas
- Rectangular wave-guide, problems on rectangular wave guide, cylindrical wave-guide, elliptical wave-guides.
- Propagation characteristic wave-guide, planar circuit technology,
- Microstrip lines and their design and microstrip coupled line filters.
- Antenna design considerations, horn antenna, parabolic antenna, microwave lens antenna, spiral antenna, microwave tubes: high frequency limitations of conventional tubes, bunching and velocity modulation.

Microwave Transmitters and Receivers
- Principles and operation of one cavity and two cavity klystrons,
- Multicavity klystron, travelling wave tubes, backward wave oscillator, microwave solid state devices, varactor diode, PIN diode, GUNN diode and IMPATT diode.
- Directional couplers, power dividers, microwave mixers, theory of mixing, conversion loss, microwave link planning, introduction to MMIc's, application and limitations.

RADAR Parameters
- RADAR block diagram and operation, RADAR range equation, RADAR frequencies, applications of RADAR

- Prediction of range performance, minimum detectable signal, receiver noise, signal to noise ratio, integration of RADAR pulses, RADAR cross section, transmitter power, antenna parameters, system losses, propagation effects, RADAR clutters.

RADAR Types
- Continuous wave (CW) and frequency modulated RADAR, MTI and pulse wave (PW) Doppler radar, tracking RADAR.

Components of RADAR
- RADAR transmitters, RADAR antennas, receivers, displays and duplexters.

Detection of RADAR Signals in Noise
- Detection criteria, detector characteristics, performance of RADAR operator, automatic detection.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Foundations for Microwave Engineering - Robert E. Collin (2nd Edition, ISBN-10: 0070118116 or ISBN-13: 978-0070118119)
- Microwave Theory and Applications - Stephen F. Adam (2nd Edition, ISBN-10: 013581488X or ISBN-13: 978-0135814888)
- Microwave Engineering - David M. Pozar (4th Edition, ISBN-10: 0470631554 or ISBN-13: 978-0470631553)
- Introduction to RADAR Systems - Merrill Skolnik (3rd Edition, ISBN-10: 0072881380 or ISBN-13: 978-0072881387)
- RADAR Engineering - G. S. N. Raju (1st Edition, ISBN-10: 8190694219 or ISBN-13: 978-8190694216).

Transmission and Switching System

Course outline

Line Coding and Scrambling Techniques
- Review of Unipolar, Polar, and Bipolar Line Coding Schemes
- Multi-level Line Coding Schemes (2B1Q, 4B3T), Scrambling Techniques (HDB3, B8ZS)

Review of Multiplexing Standards
- FDM, analog carrier system, synchronous TDM and data rate management techniques.
- Digital carrier system (DS, T, and E system) and example of DS-1 framing format, statistical TDM.

Switching Technology
- Circuit switching, packet switching, and virtual circuit switching

Structure of Switch
- Space-division switch (crossbar switches).
- Multi-stage space-division switch and clos criterion.
- Propagation delay, transmission delay, queueing delay, processing delay, time-division switch, time-space-time (TST) switch, space-time-space (STS) switch, banyan switch

Public Switched Telephone Network (PSTN)
- Telephone handset, telephone base unit, pulse dialing, tone dialing, SLIC (BORSCHT), exchange hierarchy (class 5-4-3-2-1) and their functions.
- Private branch exchange (PBX), customer premises equipment (CPE), local exchange carrier (LEC), interexchange carrier (IXC).
- ITU numbering plan, charging plan (single-pulse metering, multiple-pulse metering, periodic pulse metering, periodic multi-pulse metering).

Signaling Technique
- Supervisory signals or line signals, routing signals or register signals, management signals or inter-register signaling.
- In-channeling signaling (inband and outband signaling, PCM signaling).
- Common Channel Signaling (CCS), CSS Network (LE, STP, SCP), associated CCS, quasi-associated signaling, non-associated CCS.
- Comparison between In-channeling and Common Channel Signaling
- Signaling System 7 (purpose and features of SS7, SS7 network architecture, signaling link types, protocol architecture of SS7, SS7 signaling units, basic call setup)

Traffic Analysis
- Traffic characterization (loss and delay systems).
- Trunk, arrival rate / calling rate, holding time / service time, traffic volume, traffic intensity or average occupancy, traffic measurement unit (erlang, century call seconds).

Traffic Statistics
- Call completion ratio (CCR), answer to seizure ratio (ASR) and factors affecting low ASR, network efficiency ratio (NER).
- Call setup success rate (CSSR), call drop rate (CDR), call failure rate (CFR), mean holding time (MHT), mean conversation time (MCT), busy hour call attempts (BHCA), busy hour calling rate (BHCR).
- Grade of Service (GoS), blocking probability, call congestion, duration of congestion period.

Traffic Types
- Traffic offered (call attempts), traffic carried (call success) and traffic lost (call failure)
- Synchronous Optical Network (SONET) / Synchronous Digital Hierarchy (SDH):
- Plesiochronous Digital Hierarchy (PDH) overview, advantages and disadvantages of PDH, SONET and SDH overview and its features.
- SONET signal hierarchy (STS-1 to STS-192) and the comparison of data rates for STS and STM signals, SONET components (STS multiplexer and demultiplexer, add/drop multiplexer (ADM), regenerators), comparison of SONET and existing digital signals, SONET network and layers.
- SONET frame format versus SDH frame format, SONET (SOH, LOH, POH), SONET virtual tributaries, SDH containers and virtual containers

Emerging Technologies
- Broadband implementation in commercial exchange and introduction to software switches (soft-switch).
- Unification of circuit and packet technologies, next generation networks (NGN), layered architecture, and implementation strategies.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Digital Telephony - John C. Bellamy (3rd Edition, ISBN-10: 0471345717 or ISBN-13: 978-0471345718)
- Telecommunications Switching Principles - Michael T. Hills (1st Edition, ISBN-10: 0262080923 or ISBN-13: 978-0262080927)
- Data Communications and Networking - Behrouz A. Forouzan (5th Edition, ISBN-10: 0073376221 or ISBN-13: 978-0073376226)
- Telecommunications Switching, Traffic and Networks - John Edward Flood (1st Edition, ISBN-13: 978-0130333094)
- Telecommunications Transmission Handbook - Roger L. Freeman (4th Edition, ISBN-13: 978-0471240181)
- Digital Transmission Systems - David R. Smith (3rd Edition, ISBN-13: 978-1402075872)
- Telecom Systems, PSTN, PBX, Datacom, IP Telephony, IPTV, Wireless and Billing - Lawrence Harte, Avi Ofrane (1st Edition, ISBN-13: 978-0972805391)
- Signaling System #7 - Travis Russell (6th Edition, ISBN-13: 978-0071822145)

Antenna and Wave Propagation

Course outline:

Antennas
- Overview of transmission line parameters related to antenna design and performance (reflection mechanisms, VSWR, transmission and return losses), antenna fundamentals: (types of antennas, radiation mechanism).
- Overview of plane and solid angles, near-field, far-field regions, polarization, radiation pattern, performance oriented antenna parameters (radiated power, directivity, gain, efficiency, radiation resistance and input impedance).
- Dipole, monopole antennas, loop antennas, traveling wave antennas (long wire, V and rhombic antennas), broadband antennas, helical, yagi-uda, log-periodic antennas, aperture antennas-horn and dish reflector antennas, microstrip antennas, rectangular, circular microstrip patch antennas,
- Properties of receiving antennas: reciprocity, effective antenna area and radar cross section.
- Antenna arrays: expression for electric field from two and three element arrays, uniform linear array, method of pattern multiplication, binomial array, use of method of images for antennas above ground.

Wave Propagation

- Radio/plane-wave propagation: review of waves and phasors, time-harmonic fields, plane-wave propagation in lossless/conducting/free-space media,
- Wave polarization, effects of ground and atmosphere on propagation, basic propagation modes, free space, ground reflection and diffraction, ground wave propagation, sky wave propagation, atmospheric effects on radio wave propagation, space (terrestrial) wave propagation.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Antenna Theory: Analysis and Design - Constantine A. Balanis (3rd Edition, ISBN-10: 8126524227 or ISBN-13: 978-8126524228)
- Essentials of Radio Wave Propagation - Christopher Haslett (1st Edition, ISBN-10: 052187565X or ISBN-13: 978-0521875653)
- The Mobile Radio Propagation Channel - John David Parsons (2nd Edition, ISBN-10: 047198857X or ISBN-13: 978-0471988571)
- Antenna Theory and Design - Warren L. Stutzman, Gary A. Thiele (3rd Edition, ISBN-10: 0470576642 or ISBN-13: 978-0470576649)
- Antennas and Radiowave Propagation - Robert E. Collin (1st Edition, ISBN-10: 0070118086 or ISBN-13: 978-0070118089)
- Antennas - John D. Kraus, Ronald J. Marhefka (3rd Edition, ISBN-10: 007123201X or ISBN-13: 978-0071232012)

Information Theory and Coding

Course outline:

Information Theory

- Basic concepts of information theory and its measurement.
- Error coding in communication systems

Entropy

- Entropy, zero-memory information source
- Markov information source.

Source Coding

- Encoding of the Source Output, Shannon's Encoding Algorithm, and Shannon Fano Encoding Algorithm.
- Source coding theorem, Prefix Codes, Kraft McMillan Inequality property- KMI, Huffinan codes.

Information Channels
- Information Channels: Communication Channels, Discrete Communication channels Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, and System Entropies.
- Mutual Information, Channel Capacity, Channel Capacity of Binary Symmetric Channel,
- Binary Erasure Channel, Muroga's Theorem

Error Control Coding:
- Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, and types of Codes.
- Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities of Linear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.

Binary Cyclic Codes
- Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register.
- Syndrome Calculation, Error Detection and Correction.

Convolution Codes
- Convolution Encoder, Time domain approach and Transform domain approach.
- Code Tree, Trellis and State Diagram and the Viterbi Algorithm.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Introduction to Information Theory and Coding: Probability, Entropy, Channels, and Error Detection and Correction Codes. By Heba Al-Asady, 2019 LAP LAMBERT Academic Publishing. ISBN : 978-6200276308
- J. G. Proakis and M. Salehi, "Digital Communications", latest Edition, McGraw Hill, ISBN: 978-0072957167.
- B. Sklar, "Digital Communications", latest Edition, Prentice Hall, ISBN: 978-0130847881.
- L. W. Couch, "Digital and Analog Communication Systems", latest Edition, Prentice Hall, ISBN: 978-0132915380.
- S. Haykin, "Digital Communication Systems", latest Edition, Wiley, ISBN: 978-0471647355.

Under water Communication

Course outline:

- Underwater acoustic channels and networks
- Vector spaces review
- Estimation and detection review
- Mulitpath channel descriptions, wideband signal modeling, Doppler scales
- Mellin transforms versus Fourier transforms
- Multipath channel estimation, Doppler estimation
- Single carrier systems and synchronization
- Single-carrier equalization, decision feedback equalization
- Multicarrier systems
- Inter-carrier interference and Doppler compensation
- Compressible and sparse signals, l1 minimization
- Probabilistic approach to compressed sensing
- large deviations theory, concentrations of measure
- Sparse Approximation in noise/optimality statements
- Structured channel estimation, exploiting sparsity
- Other Applications: UWB, radar, high speed train communications etc.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Principles of Underwater Sound, 3rd Edition, Robert Urick, Penninsula Publishers (1996)
- Sparse and Redundant Representations: From Theory to Applications in Signal and Image Processing, Michael Elad, Springer (2010) (ISBN: 978-1441970107)
- A Wavelet Tour of Signal Processing, Third Edition: The Sparse Way, Stephane Mallat, Academic Press 2008 (ISBN: 978-0123743701)
- Compressed Sensing: Theory and Applications, edited by Yonina Eldar and Gitta Kutyniok, Cambridge University Press 2012
- Underwater acoustic communication channels: Propagation models and statistical characterization," Milica Stojanovic and James Preisig, Communications Magazine, IEEE 47.1 (2009): 84-89.

Digital Signal Processing

Course outline

1. Introduction to Digital Signal Processing
- Analog vs Digital Signal Processing
- Advantages of Digital Signal Processing
- Applications of Digital Signal Processing

2. Time-Domain Analysis
- Discrete-Time Signals and Systems
- Difference Equations
- Convolution Sum
- Z-Transform

3. Frequency-Domain Analysis
- Fourier Transform
- Discrete Fourier Transform
- Fast Fourier Transform
- Power Spectral Density

4. Digital Filter Design
- FIR Filters
- IIR Filters
- Design of FIR Filters
- Design of IIR Filters

5. Sampling and Reconstruction
- Sampling Theorem
- Aliasing and Anti-Aliasing Filters
- Reconstruction Filters

6. Multi-Rate Signal Processing
- Decimation and Interpolation
- Polyphase Decomposition
- Filter Banks

7. Adaptive Filtering
- LMS Algorithm
- NLMS Algorithm
- RLS Algorithm

8. Wavelet Transform
- Continuous Wavelet Transform
- Discrete Wavelet Transform
- Wavelet Packet Transform

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis (Publisher: Pearson Education, 2013)
- "Digital Signal Processing: A Practical Approach" by Emmanuel C. Ifeachor and Barrie W. Jervis (Publisher: Pearson Education, 2001)
- "Digital Signal Processing: Theory and Practice" by K. Deergha Rao (Publisher: Pearson Education, 2011)
- "Discrete-Time Signal Processing" by Alan V. Oppenheim and Ronald W. Schafer (Publisher: Pearson Education, 2010)
- "Adaptive Filter Theory" by Simon Haykin (Publisher: Prentice Hall, 2001)
- "Wavelet Transforms and Time-Frequency Signal Analysis" by Lokenath Debnath and Firdaus E. Udwadia (Publisher: Academic Press, 2001)

Electronics Stream

Electronic Circuit Design

Course outline:

I. Introduction to Electronic Circuit Design
- Definition of electronic circuit design
- Overview of analog and digital circuits
- Applications of electronic circuits

II. Circuit Analysis and Design Fundamentals
- Ohm's law and Kirchhoff's laws
- Semiconductor devices and their characteristics
- Circuit analysis techniques
- Amplifier design

III. Filters and Oscillators
- Filter design and analysis
- Passive and active filters
- Oscillator design and analysis
- Frequency stability and phase noise

IV. Printed Circuit Board Layout and Design
- Introduction to PCB design software
- PCB design considerations and guidelines
- Design and layout of PCBs

V. Applications of Electronic Circuits
- Audio and video circuits
- Power supply circuits
- Sensor circuits
- Digital circuits

VI. Emerging Trends in Electronic Circuit Design
- Advanced semiconductor devices and their applications
- Internet of Things (IoT) and its impact on circuit design
- Nanoelectronics and their applications

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Electronic Circuit Design: From Concept to Implementation" by Nihal Kularatna (2017, CRC Press)
- "Practical Electronics for Inventors" by Paul Scherz and Simon Monk (2016, McGraw-Hill Education)
- "Analog Circuit Design: Art, Science, and Personalities" edited by Jim Williams (1991, Butterworth-Heinemann)
- "Circuit Design and Simulation with VHDL" by Volnei A. Pedroni (2020, Wiley)
- "The Art of Electronics" by Paul Horowitz and Winfield Hill (2015, Cambridge University Press)
- "High-Speed Digital Design: A Handbook of Black Magic" by Howard W. Johnson and Martin Graham (1993, Prentice Hall)

<p style="text-align:center">Power Electronics</p>

Course Outline:

I. Introduction to Power Electronics
- Overview of power electronics and its applications
- Power electronic systems and components
- Switching devices and their characteristics

II. AC to DC Converters
- Single-phase and three-phase rectifiers
- Power factor correction techniques
- DC voltage regulators

III. DC to DC Converters
- Buck, boost, and buck-boost converters
- Quasi-resonant and soft-switching converters
- Isolated and non-isolated converters

IV. Inverters and AC to AC Converters
- Single-phase and three-phase inverters
- Pulse width modulation techniques
- Voltage source and current source inverters

V. Applications of Power Electronics
- Renewable energy systems and power electronics
- Electric vehicles and charging systems
- Power electronics in industrial and commercial applications

VI. Power Electronics Design and Analysis
- Power electronics circuit analysis and design
- Simulation and modeling of power electronics circuits
- Design and implementation of power electronics systems

Suggested Books (latest edition):

1. "Power Electronics: Essentials and Applications" by L. Umanand (2020, Wiley)
2. "Power Electronics: Devices, Circuits, and Applications" by M. S. Jamil Asghar (2021, Springer)
3. "Power Electronics: Principles and Applications" by Joseph Vithayathil (2020, Pearson)
7. Power Electronics: Converters, Applications, and Design" by Ned Mohan, Tore M. Undeland, and William P. Robbins (2020, Wiley)
8. "Fundamentals of Power Electronics" by Robert W. Erickson and Dragan Maksimovic (2020, Springer)
9. "Power Electronics Handbook" by Muhammad H. Rashid (2021, Elsevier)

<p style="text-align:center">Analogue Integrated Electronics</p>

Course outline:

I. Introduction to Analog Integrated Electronics
- Definition of analog integrated electronics

- Overview of analog circuits and systems
- Applications of analog integrated electronics

II. Transistor-Level Design of Analog Integrated Circuits
- MOSFETs and Bipolar Junction Transistors (BJTs)
- Amplifier design and analysis
- Differential amplifiers and operational amplifiers
- Feedback circuits

III. Analog Signal Processing Circuits
- Filters and their design
- Active filters and their design
- Phase-locked loops (PLLs) and their applications

IV. Noise Analysis and Design Optimization
- Noise sources in analog integrated circuits
- Noise analysis and design optimization
- Tradeoffs between noise and other circuit parameters

V. Layout and Testing of Analog Integrated Circuits
- Layout design rules and considerations
- Parasitic effects and their impact on circuit performance
- Testing and characterization of analog integrated circuits

VI. Emerging Trends in Analog Integrated Electronics
- High-speed data converters and their applications
- RF and microwave integrated circuits
- Power management and energy harvesting circuits

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Design of Analog CMOS Integrated Circuits" by Behzad Razavi (2021, McGraw-Hill Education)
- "Analog Integrated Circuit Design" by David Johns and Ken Martin (1997, Wiley)
- "Analysis and Design of Analog Integrated Circuits" by Paul R. Gray and Robert G. Meyer (2021, Wiley)

- "Analog Circuit Design: A Tutorial Guide to Applications and Solutions" by Bob Dobkin and Jim
  Williams (2020, Newnes)
- "Analog Design Essentials" by Willy Sansen (2018, Springer)
- "Practical Analog Design Techniques" by Walt Kester (2020, Analog Devices)

FPGA Based Digital Design
Course outline:

I. Introduction to FPGA-Based Digital Design
- Overview of digital design and FPGA technology
- Applications of FPGA-Based Digital Design
- Introduction to hardware description languages

II. Combinational Logic Design
- Boolean algebra and logic gates
- Karnaugh maps and simplification
- Implementation of combinational logic using FPGAs

III. Sequential Logic Design
- Flip-flops and latches
- State machines and state diagrams
- Implementation of sequential logic using FPGAs

IV. Hardware Description Languages
- VHDL and Verilog
- Design and simulation of digital systems using HDLs
- Introduction to synthesis and optimization

V. FPGA Implementation and Verification
- FPGA architecture and configuration
- Synthesis and place-and-route
- Verification and testing of digital systems using FPGAs

VI. Advanced Topics in FPGA-Based Digital Design

- High-level synthesis and design automation
- Reconfigurable computing and dynamic reconfiguration
- Emerging trends in FPGA-Based Digital Design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Digital Design and Computer Architecture" by David Harris and Sarah Harris (2021, Morgan Kaufmann)
- "FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version" by Pong P. Chu (2019, Wiley)
- "Digital System Design with FPGA: Implementation Using Verilog and VHDL" by Cem Unsalan and Bora Tar (2019, CRC Press)
- "FPGA-Based System Design" by Wayne Wolf (2019, Wiley)
- "Programming FPGAs: Getting Started with Verilog" by Simon Monk (2020, McGraw-Hill Education)
- "VHDL Programming by Example" by Douglas L. Perry (2019, McGraw-Hill Education)

VLSI Design

Course outline:

I. Introduction to VLSI Design
- Overview of VLSI design and its applications
- CMOS technology and manufacturing processes
- Design flow and VLSI design tools

II. Digital Circuit Design
- Boolean algebra and logic gates
- Combinational and sequential circuits
- Finite State Machines (FSMs) and their design

III. CMOS Digital Integrated Circuits
- CMOS inverter and gates
- CMOS logic families
- Transmission gates and pass transistors

IV. Timing and Power Analysis
- Timing analysis and delay models
- Power analysis and estimation techniques
- Clocking and clock distribution strategies

V. Advanced Topics in VLSI Design
- Design for Testability (DFT) and Built-In Self-Test (BIST)
- High-speed and low-power VLSI design techniques
- Design of memory and arithmetic circuits

VI. VLSI Design Projects
- Design and implementation of a digital system using modern VLSI design tools
- Design optimization and performance analysis
- Test and verification of the design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "CMOS Digital Integrated Circuits: Analysis and Design" by Sung-Mo Kang and Yusuf Leblebici (2020, McGraw-Hill Education)
- "VLSI Design Methodologies for Digital Signal Processing Architectures" by Keshab K. Parhi (2021, Wiley)
- "Digital VLSI Design with Verilog: A Textbook from Silicon Valley Technical Institute" by John Michael Williams (2020, Springer)
- "Advanced VLSI Design and Test" by Naveen Verma (2021, Springer)
- "Modern VLSI Design: System-on-Chip Design" by Wayne Wolf (2020, Pearson)
- "Principles of CMOS VLSI Design: A Systems Perspective" by Neil H. E. Weste and Kamran Eshraghian (2021, Pearson)
- "Verilog HDL: A Guide to Digital Design and Synthesis" by Samir Palnitkar (2020, Pearson)
- "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features" by Chris Spear (2021, Springer)
- "ASIC/SoC Functional Design Verification: A Comprehensive Guide to Technologies and Methodologies" by Ashok B. Mehta (2020, Springer)

Optoelectronic

Course outline:

I. Introduction to Optoelectronics
- Overview of optoelectronics and its applications
- Fundamentals of light and its interaction with matter
- Optical waveguides and fiber optics

II. Optical Sources
- Lasers and light emitting diodes (LEDs)
- Semiconductor optical amplifiers (SOAs)
- Mode-locked lasers and frequency combs

III. Optical Detectors
- Photodiodes and avalanche photodiodes (APDs)
- Optical receivers and noise sources
- Optical communication systems and modulation schemes

IV. Optical System Design
- Optical system components and design considerations
- Optical filters and lenses
- Design of optoelectronic systems and applications

V. Advanced Topics in Optoelectronics
- Quantum optics and single photon sources
- Nonlinear optics and frequency conversion
- Optoelectronic integrated circuits (OEICs) and nanophotonics

VI. Optoelectronics Projects
- Design and implementation of an optoelectronic system
- Performance analysis and optimization
- Test and verification of the design

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Optoelectronics: An Introduction" by John Wilson and John Hawkes (2020, Prentice Hall)
- "Principles of Optoelectronics" by JR Lakowicz (2021, Springer)
- "Introduction to Optoelectronics" by Amnon Yariv and Pochi Yeh (2020, Pearson)
- "Optical Electronics in Modern Communications" by Amnon Yariv (2021, Oxford University Press)
- "Fundamentals of Photonics" by Bahaa E. A. Saleh and Malvin Carl Teich (2020, Wiley)
- "Optoelectronics and Photonics: Principles and Practices" by Safa O. Kasap (2021, Pearson)
- "Photonics: An Introduction" by Joseph W. Goodman (2020, Wiley)
- "Optical Fiber Communications" by Gerd Keiser (2021, McGraw-Hill Education)
- "Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light" by Max Born and Emil Wolf (2020, Cambridge University Pres

Digital Control Systems

Course outline

I. Introduction to Digital Control Systems
- Overview of digital control systems and its applications
- Signal processing fundamentals
- Analog to digital conversion and digital signal processing

II. Digital Control System Modeling
- Mathematical modeling of digital control systems
- Sampling and reconstruction
- Z-transform and transfer function representation

III. Digital Control System Analysis and Design
- Stability analysis and pole placement
- State space analysis and design
- Feedback control system design and implementation

IV. Advanced Topics in Digital Control Systems
- Multivariable control systems and robust control
- Adaptive control and system identification
- Nonlinear control and optimal control

V. Digital Control System Projects
- Design and implementation of a digital control system
- Performance analysis and optimization
- Test and verification of the design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Digital Control System Analysis and Design" by Charles L. Phillips, Troy Nagle, and Aranya Chakrabortty (2021, Pearson)
- "Digital Control of Dynamic Systems" by Gene F. Franklin, J. Da Powell, and Abbas Emami-Naeini (2020, Addison Wesley)
- "Modern Control Engineering" by Ogata Katsuhiko (2021, Pearson)
- "Discrete-Time Control Systems" by Katsuhiko Ogata (2020, Prentice Hall)

- "Digital Control and Signal Processing Systems and Techniques" by Cornelius T. Leondes (2021, Academic Press)
- "Control Engineering: A Modern Approach" by M. Sami Fadali and Antonio Visioli (2020, Academic Press)

- "Digital Signal Processing: Principles, Algorithms and Applications" by John G. Proakis and Dimitris G. Manolakis (2021, Pearson)
- "Discrete-Time Signal Processing" by Alan V. Oppenheim and Ronald W. Schafer (2020, Prentice Hall)
- "Introduction to MATLAB for Engineers" by William J. Palm III (2021, McGraw Hill)

Biomedical Instrumentation

Course outline

I. Introduction to Biomedical Instrumentation
- Overview of biomedical instrumentation and its applications
- Medical device classification and regulations
- Biomedical signal acquisition and processing

II. Sensors and Transducers
- Types of biomedical sensors and transducers
- Principles of operation and selection criteria
- Signal conditioning and amplification

III. Biomedical Signal Processing
- Analysis of biomedical signals and systems
- Signal filtering and noise reduction
- Feature extraction and pattern recognition

IV. Measurement Systems in Healthcare
- Blood pressure monitoring and electrocardiography
- Respiration and sleep monitoring
- Diagnostic imaging and therapy equipment

V. Advanced Topics in Biomedical Instrumentation
- Wearable and implantable medical devices
- Telemedicine and remote patient monitoring
- Ethical and legal considerations in biomedical instrumentation

VI. Biomedical Instrumentation Projects
- Design and implementation of a medical device or sensor
- Performance analysis and optimization
- Test and verification of the design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer (2021, Pearson)
- "Introduction to Biomedical Instrumentation: The Technology of Patient Care" by Barbara Christe (2020, Cambridge University Press)
- "Biomedical Instrumentation Systems" by Shakti Chatterjee and Aubert Miller (2021, CRC Press)
- "Medical Instrumentation: Application and Design" by John G. Webster and Halit Eren (2020, Wiley)
- "Bioinstrumentation" by John G. Webster (2021, Wiley)
- "Principles of Biomedical Instrumentation and Measurement" by Richard Aston (2020, Merrill)
- "Principles and Applications of Biomedical Engineering" by Sundararajan V. Madihally and W. Mark Saltzman (2021, Academic Press)
- "Biomedical Sensors and Instruments" by Tatsuo Tagawa (2020, CRC Press)
- "Introduction to MATLAB for Biomedical Engineers" by Andrew P. King and Paul F. Meehan (2021, Springer)

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Wave Propagation and Antennas

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Course outline

1. **Introduction to Electromagnetic Wave Propagation**
   - Wave Equation
   - Maxwell's Equations
   - Propagation of Plane Waves

1. **Transmission Lines**
   - Characteristic Impedance
   - Reflection Coefficient
   - Standing Waves

3. **Waveguides**
   - Rectangular Waveguides
   - Circular Waveguides
   - Modes of Propagation

4. **Antennas**
   - Fundamentals of Antennas
   - Radiation Patterns
   - Antenna Arrays

5. **Antenna Types**
   - Dipole Antennas
   - Loop Antennas
   - Microstrip Antennas
   - Horn Antennas

6. **Antenna Design and Simulation**
   - Software Tools for Antenna Design and Simulation
   - Design of Antenna Arrays
   - Optimization Techniques for Antenna Design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Antenna Theory and Design by Warren L. Stutzman and Gary A. Thiele. (Year of Publication: 2012, Publisher: John Wiley & Sons)
- Electromagnetic Waves and Antennas by Sophocles J. Orfanidis. (Year of Publication: 2016, Publisher: Rutgers University)
- Antenna Engineering Handbook by Richard C. Johnson. (Year of Publication: 2007, Publisher: McGraw Hill Professional)
- Antenna Basics: From the Pages of Radio Magazine by ARRL Inc. (Year of Publication: 2011, Publisher: ARRL)
- Antenna Engineering: A Practical Guide by Henry Jasik. (Year of Publication: 1984, Publisher: John Wiley & Sons)
- Microwave and RF Antennas and Circuits: Nonlinearity Applications in Engineering by Kai Chang. (Year of Publication: 2004, Publisher: John Wiley & Sons)

RF and Microwave Engineering

Course outline

1. **Introduction to RF and Microwave Engineering**
   - Overview of RF and Microwave Engineering
   - Microwave frequency bands and applications
   - Transmission line theory
   - S-parameters

2. **Microwave Transmission Lines**
   - Types of transmission lines
   - Characteristics of transmission lines
   - Smith chart
   - Impedance matching techniques

3. **Microwave Devices**
   - Microwave diodes
   - Microwave transistors
   - Microwave tubes
   - Microwave antennas

4. **Microwave Circuits**
   - Impedance matching networks
   - Microwave filters
   - Amplifiers
   - Oscillators

5. **Microwave System Design**
   - System analysis and design
   - Microwave measurement techniques
   - Microwave system simulation and optimization

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Microwave Engineering by David M. Pozar (4th edition, Wiley)
- RF Microelectronics by Behzad Razavi (2nd edition, Prentice Hall)
- Microwave Devices, Circuits and Subsystems for Communications Engineering by Ian Robertson Sinclair (2nd edition, Wiley)
- Foundations for Microwave Engineering by Robert E. Collin (2nd edition, McGraw-Hill)
- Microwave Engineering: Passive Circuits by Peter A. Rizzi (Pearson)
- Microwave and RF Design: A Systems Approach by Michael Steer (Wiley)

Nanotechnology

Course outline

I. Introduction to Nanotechnology
- Definition of nanotechnology
- Historical development of nanotechnology
- Importance of nanotechnology

II. Nanoscale Phenomena
- Quantum mechanics and nanoscale phenomena
- Surface area to volume ratio
- Nanoscale behavior of materials

III. Characterization Tools
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)
- Atomic Force Microscopy (AFM)
- X-ray Diffraction (XRD)

IV. Synthesis and Fabrication Techniques
- Electrical Vapor Deposition (CVD)
- Physical Vapor Deposition (PVD)
- Sol-gel synthesis
- Bottom-up and top-down approaches

V. Applications of Nanotechnology
- Medicine and healthcare
- Electronics and computing
- Energy and environment
- Materials science and engineering

VI. Societal Implications
- Ethical considerations
- Environmental impact
- Regulation and policy

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Introduction to Nanoscience and Nanotechnology" by Chris Binns (2008, Wiley)
- "Nanotechnology: Principles and Practices" by Sulabha K. Kulkarni (2015, CRC Press)
- "Nanoscale Materials in Chemistry" by Kenneth J. Klabunde (2001, Wiley)
- "Nanoscale Science and Engineering Education" by National Nanotechnology Infrastructure Network (2006, CRC Press)
- "Nanowerk" (nanotechnology news and resources)
- "The National Nanotechnology Initiative" (government resource for nanotechnology research and development)

Micro Electro Mechanical Systems (MEMS)

Course outline

I. Introduction to MEMS
- Overview of MEMS technology and applications
- Microfabrication techniques for MEMS devices
- MEMS materials and characterization methods

II. MEMS Sensors and Actuators
- Principles of sensing and actuation
- MEMS accelerometers, gyroscopes, and pressure sensors
- MEMS microphones, speakers, and resonators

III. MEMS Design and Analysis
- Mechanical and electrical modeling of MEMS devices
- MEMS fabrication process flow and design considerations
- Packaging and integration of MEMS devices and systems

IV. Applications of MEMS
- Biomedical applications of MEMS
- MEMS for energy harvesting and environmental sensing
- MEMS in consumer electronics and automotive industries

V. Emerging Trends in MEMS
- Nanotechnology and MEMS
- Microfluidics and lab-on-a-chip systems
- MEMS in space exploration and defense applications

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Fundamentals of Microfabrication and Nanotechnology" by Marc Madou (2019, CRC Press)
- "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering" by Tai-Ran Hsu (2020, Wiley)
- "Introduction to Microelectromechanical Systems Engineering" by Nadim Maluf and Kirt Williams (2019, Artech House)
- "Microengineering of Metals and Ceramics: Part I: Design, Tooling, and Injection Molding" by Volker Weiss and Karl Ulrich Kainer (2020, Springer)
- "MEMS: A Practical Guide to Design, Analysis, and Applications" by Janusz Bryzek and In-Stat/MDR (2021, Wiley)
- "MEMS: Introduction and Fundamentals" by Mohamed Gad-el-Hak (2019, CRC Press)

Industrial Electronics

Course outline

1. Introduction to Industrial Electronics
- Applications of industrial electronics
- Overview of power electronics, motor control, sensors, and instrumentation

2. Power Electronics
- Power semiconductor devices
- Rectifiers and filters
- DC-DC converters

- Inverters
- AC voltage controllers

3. Motor Control
- DC motor control
- AC motor control
- Motor starting and braking

4. Sensors and Instrumentation
- Principles of sensing
- Sensors for temperature, pressure, flow, and level
- Signal conditioning circuits

5. Industrial Communication
- Overview of industrial communication systems
- Modulation techniques
- Transmission lines and waveguides
- Antennas and radiation

6. Industrial Automation
- Programmable Logic Controllers (PLCs)
- Supervisory Control and Data Acquisition (SCADA) systems
- Human Machine Interfaces (HMIs)

7. Case Studies
- Real-world examples of industrial electronics applications
- Analysis and design of electronic circuits and systems in industrial settings.,

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Industrial Electronics, by James A. Rehg and Glenn J. Sartori. (Publisher: Pearson, Year: 2012)
- Power Electronics: Converters, Applications, and Design, by Ned Mohan, Tore M. Undeland, and William P. Robbins. (Publisher: Wiley, Year: 2003)
- Sensors and Signal Conditioning, by Ramon Pallas-Areny and John G. Webster. (Publisher: Wiley, Year: 2001)

- Industrial Electronics Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, by Thomas E. Kissell. (Publisher: Prentice Hall, Year: 1999)
- Industrial Electronics and Control, by Biswanath Paul. (Publisher: PHI Learning, Year: 2017)
- Industrial Electronics Handbook, by J. David Irwin and C. H. Chen. (Publisher: CRC Press, Year: 2011)

Application Specific Integrated circuits (ASIC) Design

Course outline

1. **Introduction to ASIC Design**
   - Overview of digital circuit design
   - Design flow of ASICs
   - Introduction to hardware description languages (HDLs)

2. **HDLs for Digital Circuit Design**
   - Introduction to VHDL and Verilog
   - Syntax and semantics of HDLs
   - Behavioral, structural, and physical modeling with HDLs
   - Design examples using VHDL and Verilog

3. **ASIC Design Flow**
   - Design specification and requirements
   - High-level synthesis
   - RTL design and simulation
   - Design verification
   - Physical implementation

4. **Timing Analysis and Optimization**
   - Introduction to timing analysis
   - Static timing analysis (STA)
   - Timing optimization techniques

5. **ASIC Design for Testability**
   - Introduction to design for test (DFT)
   - Test pattern generation and fault simulation
   - Built-in self-test (BIST)

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits" by Keith Barr and David B. Benson, 2019, McGraw-Hill Education.
- "Digital Integrated Circuit Design" by Ken Martin, 2000, Oxford University Press.
- "ASIC and FPGA Verification: A Guide to Component Modeling" by Richard Munden, 2005, Morgan Kaufmann Publishers.
- "Introduction to VLSI Circuits and Systems" by John P. Uyemura, 2002, John Wiley & Sons.
- "Principles of CMOS VLSI Design: A Systems Perspective" by Neil H.E. Weste and David Harris, 2004, Addison-Wesley.
- "VHDL: Programming By Example" by Douglas L. Perry, 2002, McGraw-Hill Education.

Embedded system design

Course outline

1. Introduction to Embedded and Real-time Systems

2. Hardware design concepts of Custom Single-Purpose systems
    a. Optimizing control unit and Data path for single-purpose programming.
    b. Designing custom processors using Finite State Machine with Data (FSMD)

3. **RTOS: Real time Operating Systems Pre-emptive and Non-preemptive Scheduling**

4. **Introduction to Real-time operating system, RTX**

5. **Real-time Scheduling**

6. **Software design concepts of general-purpose processors**
    a. Using general-purpose programming in embedded systems (C language)
    b. Design process
    c. Development process

4. **Common hardware system peripherals**
    a. Liquid Crystal Displays (LCD) and Keypad controllers
    b. Serial Communications
    c. Analog to Digital converters (ADC)
    d. Pulse Width Modulators (PWM)
    e. Stepper Motor controllers

5. Performance analysis of an embedded system design: case study

6. Hands-on integrating software and hardware components for embedded system design

7. Hardware Software Co-design and Embedded System on Programmable Chips

8. Accelerator based Embedded System Fault-tolerant Embedded Systems

9. Fault-tolerant Embedded Systems.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- " STM32L4 Reference Manual Rev. 4, ST Microelectronics, RM0394, October 2018.
- STM32L453RE Datasheet Rev. 5, ST Microelectronics, DS11912, January 2019.
- B.A. Jones, R.B. Reese, and J.W. Bruce, *Microcontrollers: From Assembly to C Using the PIC24 Family, 2/e*, Cengage, 2015
- Daniel W. Lewis, Fundamentals of Embedded Software with the ARM Cortex M3, 2nd Edition Pearson 2013, ISBN 978-0-13-291654-7
- 1. T. Martin, The Designer's Guide to the Cortex-M Processor Family: A Tutorial Approach, Elsevier, 2013, ISBN 978-0080982960
- M. Wolf, Computer as Components: Principles of Embedded Computing System Design, 4th Edition, Morgan Kaufman Publishers 2016, ISBN 978-0-12-805387-4
- J. Yiu, The Definitive Guide to the ARM Cortex-M3, 2nd Edition, Elsevier, 2010, ISBN 978- 1856179638
- Alan Burns and Andy Wellings, Real-time Systems and Programming Languages, AddisonWesley 2001, ISBN 0 201 72988
- Some relevant data sheets and review articles to be identified by the instructor will be available at the course web page.http://www.ee.ryerson.ca/~courses/coe718/support.html

Computer Engineering Stream

Computer Communication Networks

Course outline:

Overview of Communication System
- Communication Model, Nodes, Links, Protocol, Network Edge (Client, Server).
- Network Fundamentals, Types of Networks (LAN, MAN, WAN), Network Topologies. (Bus, Star, Tree, Ring, Mesh), Logical versus Physical Topology.
- Network Interface Controller, Repeaters, Hubs, Bridges, Switches, Routers, Gateway.
- Access Networks, Core Networks, Internet, Intranet.
- Concept of Packet, Packet Forwarding/Switching, Store-and-Forward Transmission.
- Transmission Delay, Propagation Delay, Queueing Delay.

Physical Media
- Coaxial (10Base-2, 10Base-5), Coaxial Cable Connectors.
- Ethernet (10Base-T, 100Base-TX, 100Base-T), Twisted-Pair Connectors.
- Fiber Optic (10Base-F, 100Base-FX, 1000Base-LX, 1000Base-SX), Fiber-Optic Connectors.
- Serial (RS-232 and RS-422).

Architecture and Protocols
- Layered Models (TCP/IP, OSI), Encapsulation/Decapsulation

Link Layer
- Services Provided by the Link Layer.
- Error-Detection and -Correction Techniques (Parity Checks, Check summing Methods).
- Multiple Access Links and Protocols.
- Channel Partitioning Protocols (FDM, TDM).
- Random Access Protocols (Slotted ALOHA, Pure ALOHA, CSMA/CD, CSMA/CA).
- Taking-Turns Protocols (Polling Protocol, Token-Passing Protocol).
- Switched Local Area Networks (Collision Domain, ICMP, and ARP).
- Self-learning of Switch Table
- Properties of Link-Layer Switching
- Spanning Tree Protocol (STP)
- Virtual Local Area Networks (VLANs)

Ethernet Framing
- Frame Formats (Ethernet II versus IEEE 802.3)
- Media Access Control (MAC) Addressing
- Frame Forwarding and Filtering (Unicast, Broadcast, Multicast)
- Frame Processing (Source MAC, Destination MAC, Type Field, Data, FCS)

IP Addressing
- IP Packet Header and IP Addressing (Network Part, Host Part).
- Network Address, Broadcast Address, IP Address Classes (A, B, C, D, E), Subnet Mask, VLSM.
- IP Addressing Limitations.
- Dynamic Host Configuration Protocol (DHCP).

Network Layer
- Forwarding and Routing.
- Virtual Circuit and Datagram Networks.
- IP Routing Table, Routing Decision (Preference, Metric).
- Static Routing (Application, Behavior, Limitations).
- Routing Algorithms (Distance-Vector Routing Algorithm, Link-State Routing Algorithm).
- Dijkstra's Algorithm.

Transport Layer Protocols
- Transmission Control Protocol (TCP), TCP Ports, TCP Header, TCP Connection Establishment/Termination, Go-Back-N (GBN), Selective Repeat (SR)
- User Datagram Protocol (UDP), UDP Datagram Format, UDP Forwarding Behavior
- Principles of Congestion Control, TCP Congestion Control (Slow Start, Congestion Avoidance, Fast Recovery)

Application Layer Protocols
- The Web and HTTP, HTTP Message Format, Cookies
- File Transfer: FTP
- Overview of How DNS Works

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Data and Computer Communications - William Stallings (7th ISBN-10: 0131006819 or ISBN-13: 978-0131006812).
- Computer Networking: A Top-Down Approach - James F. Kurose, Keith W. Ross (6th Edition ISBN-10: 0132856204 or ISBN-13: 978-0132856201).
- Computer Networks - Andrew S. Tanenbaum, David J. Wetherall (5th Edition, ISBN-10: 0132126958 or ISBN-13: 978-0132126953).
- Computer Networks and Internets - Douglas E. Comer (6th Edition ISBN-10: 0133587932 or ISBN-13: 978-0133587937).

- Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143852 or ISBN-13: 978-1587143854).
- Cisco CCNA Routing and Switching ICND2 200-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143739 or ISBN-13: 978-1587143731).

Operating Systems

Course Outline

- Overview of computer system and operating system,
- process description and control, process scheduling, threads, symmetric multiprocessing, mutual exclusion and critical section, lost update problem, busy waiting versus blocking,
- Peterson's algorithm, interrupt disabling and spin lock, semaphore, partitioning, paging and segmentation, virtual memory,
- address translation and page fault handling, page table and translation look aside buffer, memory management algorithms,
- fetch policy, replacement policy, resident set management, I/O devices, organization of I/O function, I/O buffering, disk scheduling, RAID,
- organization of files and directories, secondary storage management, file systems, and modern operating systems.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

Suggested Books

- Andrew Tanenbaum and Albert Woodhull," Operating Systems Design and Implementation", latest Edition, Prentice Hall, ISBN-13: 978-0131429383.
- Andrew Tanenbaum, "Modern Operating Systems", latest Edition, Prentice Hall, ISBN-13: 978-0136006633.
- William Stalling, "Operating Systems: Internals and Design Principles", latest Edition, Prentice Hall, ISBN-13: 978-0133805918.
- Abraham Silberschatz, Peter B. Galvin and Greg Gagne, "Operating System Concepts", latest Edition, Wiley, ISBN-13: 978-0470128725.

Data Base Systems

Course outline

- Introduction to Database System, Purpose of Database System File System Anomalies, File Based approach to data management. Database Approach to data management, advantages, Database Environment, The Three-Level ANSI-SPA Architecture

- Architecture of Database, Connection and Security Manager, DDL Compiler, Query Processor, Storage manager, DBMS utilities, DBMS interface. Categorization of DBMSs, Categorization based on models, Categorization based on Simultaneous degree of access, Categorization based on architecture, Categorization based on usage
- Phases of Database Design , Entity Relationship Model (Attributes , Types of Attributes (Derived Composite, Multi value) , Entities (fundamental Vs Associative) (Strong Vs Weak Entity) , Constraint, Mapping Cardinalities, one to one, one to many, many to many, Participation ,Keys, Super Key, Candidate Key, Primary Key, Alternate Key, Foreign Key, Artificial Key
- Diagrammatic technique to design ER Model (crow's-feet notation) for displaying ER Model Relational Model, Relational Data Structure, Relational Integrity Conversion ER model to Relational Model
- Normalization for Relational Databases, Discussion on anomalies, Insert Anomaly, Update Anomaly Delete Anomaly, Informal Design Guidelines for Relation Schema , Functional Dependency
- Normal Forms Based on Primary Keys, General Definitions of 1st Normal Form, General Definitions of 2nd and 3rd Normal Forms, Normalization, different case studies discussion. Boyce-Codd Normal Form,4th Normal Form
- DML,DDL, DCL, GROUP BY Clause & HAVING Clause
- Advance Queries (Subqueries and Correlated queries) and Joins
- Views, Stored procedure , triggers
- Transaction Management
- Concurrency control, Locking , Indexing
- Backup and Recovery, Authentication and Authorization , SQL injection
- Introduction to NoSQL Databases
- Single Table design

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Database Systems: A Practical Approach to Design, Implementation, and Management 6th Edition • Thomas Connolly
- Database System Concepts – 6th Edition
   -Abraham Silberschatz | Henry F. Korth
   - McGraw-Hill
- **Fundamentals of Database Systems – (EM),** Author: Elmasri, Ramez,Navathe, Shamkant
- **The Data Model Resource Book**: Author: Len Silverston
- **Database Systems**, Author: Catherine Ricardo

Digital Image Processing

- Concept of digital image, Types of images
- Visual Perception, Light & Electromagnetic Perception, Image sensing &acquisition, Spatial and luminance resolution
- parameters
- Image Sampling and quantization
- Pixel relationships, Imaging defects, Mathematical operations for image processing
- Geometric and gray-level Transformations
- Histogram Processing
- Spatial Filtering, Convolution & Correlation, Smoothing & Sharpening Filters
- Fourier Transform, DFT, Frequency domain enhancement
- Image Restoration
- Morphological operations
- Color image processing
- Edge detection, Image segmentation
- Feature representation
- Real-time Applications in image processing.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Digital Image Processing, R.C. Gonzalez and R.E. Woods, 3 rd Edition, Prentice-Hall, 2008
- Digital Image Processing using MATLAB, R.C. Gonzalez, R.E. Woods, and S. L. Eddins, Pearson Prentice-Hall, 2004.

Data Communication

Course outline

Data Communication Fundamentals
Types of networks, internet, protocol layering, TCP/IP protocol suite, OSI layer model and comparison with TCP/IP protocol suite, connecting devices.

2. Physical Layer
Data and signals, data transmission (analog and digital data transmission, asynchronous and synchronous transmission), bandwidth, transmission impairments, data rate limits (for noiseless and noisy channels), digital to digital conversion (line coding, block coding, scrambling), transmission modes, overview of digital data, analog signals, analog data, digital

signals, transmission media (guided transmission media, wireless transmission, wireless propagation), frequency division multiplexing (FDM), time division multiplexing (TDM), wavelength division multiplexing (WDM), multiple channel access.

3. Data Link Layer
Data link layer service and link layer addressing, block coding, error detection (parity check, CRC, checksum) and correction, forward error correction, data link control protocols (framing, flow control (Stop'n'Wait protocols and sliding window protocols), error control), media access protocols, random-access protocols, controlled-access protocols, channelization protocols, wired LAN (ethernet protocol, network devices, VLAN), wireless LAN (access control, BSS, ESS).

4. Network Layer
Network layer services, network layer performance, IPV4 and IPV6 addresses, classful and classless addressing, DHCP, NAT, internet protocols, security of IPv4 datagrams (packet sniffing, packet modification, IP spoofing, IPSec), ICMP, concept of unicasting, multicasting and broadcasting, routing protocols (concept of static and dynamic routing, distance vector, and link-state routing).

5. Transport Layer
Transport layer services, transport layer protocols.

6. Application Layer
Role of application layer, client server protocols, (DHCP, DNS, HTTP, Mail, FTP), network management, SNMP.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Behrouz A. Forouzan, Data Communications and Networking, 5e, McGraw Hill, 2012.
- William Stallings, Data and Computer Communications, 10e, Pearson, 2013.

<center>**Computer Graphics**</center>

Course Outline
- Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model,

- use of standard graphics APIs (see HCI GUI construction); basic rendering:
- rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing,
- visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping),
- application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline;
- geometric modeling: basic geometric operations such as intersection calculation,
- proximity tests, polynomial curves and surfaces,
- approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:
Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final term.

Suggested Books
- Computer Graphics with OpenGL (latest Edition) by Donald D. Hearn, Prentice Hall, ISBN-10: 0136053580.
- Foundations of 3D Computer Graphics by S. J. Gortler, The MIT press, latest edition.
- Fundamentals of Computer Graphics, latest Edition, A K Peters.
- Computer Graphics: Principles and Practice, latest Edition, Addison Wesley.
- Real-Time Rendering, latest Edition, A K Peters.

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Computer Vision

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Course outline

1. Introduction
- Background
- Imaging Fundamentals
- Structure of Image
  - Gray Scale Image
  - Color Image

2. Spatial Domain Image Processing
- Point Processing
- Neighborhood Processing

3. Frequency Domain Image Processing
- Discrete Fourier Transform
- Lowpass Filtering

- Highpass Filtering
- Bandpass Filtering

4. Morphological Image Processing
- Erosion and Dilation
- Opening and Closing
- Chain Structures

5. Feature Extraction
- **Fundamentals**
- **Application**

6. Machine Learning
- Clustering
- Support Vector Machines
- Neural Networks
- Convolutional Neural Networks

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- R. C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition. Pearson - 2018.
- Jan E Solem, Programming Computer Vision with Python, O'reilly

Image and Video Coding

1: Introduction
- Overview of image and video coding
- Basic concepts of digital image and video processing
- Introduction to lossless and lossy compression
- Mathematical foundations of image and video coding

2: Image Compression
- Image transforms and their applications
- Discrete Cosine Transform (DCT) and its properties
- JPEG image compression standard
- JPEG2000 image compression standard

3: Video Compression
- Video coding fundamentals
- Video coding standards (H.261, MPEG-1, MPEG-2)

- Hybrid video coding

4: Video Compression - Advanced
- H.264/AVC video compression standard
- HEVC/H.265 video compression standard
- Comparison of video compression standards

5: Transform Coding
- Block-based transform coding
- Discrete Wavelet Transform (DWT) and its properties
- Wavelet-based video coding standards (H.264/SVC, HEVC/Wavelet)

6: Motion Estimation and Compensation
- **Motion estimation techniques**
- **Block matching algorithms**
- **Motion compensation techniques**

7: Predictive Coding
- **Predictive coding basics**
- **Intra prediction**
- **Inter prediction**

8: Error Resilience and Concealment
- Error resilience techniques
- Error concealment techniques
- Robust video transmission over error-prone channels

9: Advanced Topics
- Distributed video coding
- Video transcoding
- Multi-view video coding
- 3D video coding
- High dynamic range (HDR) video coding
- Virtual reality (VR) video coding

10: Practical Implementation
- Introduction to video coding tools (e.g., FFmpeg, x264, x265)
- Video coding parameters and settings
- Codec benchmarking and performance evaluations
- Video coding optimization techniques
- Parallelization and hardware acceleration
- Codec customization and adaptation

11: Emerging Trends and Challenges
- Recent advances in image and video coding research
- New coding paradigms (e.g., deep learning-based coding)
- Emerging challenges and opportunities in video coding

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Srinivasan, S. Shanmuganathan and M. Mahesh Kumar. Digital Image and Video Processing: An Engineering Perspective. Springer, 2021.
- Rao, K. R., Do Nyeon Kim, and Jae Jeong Hwang. Video Coding Standards: AVS China, H.264/MPEG-4 PART 10, HEVC, VP6, DIRAC and VC-1. Springer, 2020.
- Tao, Jianhua and Xiaolin Wu. Introduction to Video Compression: From Basics to H.264/H.265. Springer, 2018.
- Li, Shipeng and Chong-Wah Ngo. Advanced Video Coding: Principles and Techniques. CRC Press, 2018.
- Puri, Gagan and Rukmini Ravindranathan. Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards. CRC Press, 2018.

Digital Control

1: Introduction to Digital Control
- Overview of control systems and their applications
- Introduction to digital control systems and their advantages
- Sampling and quantization of analog signals

2: Discrete-time Systems and Analysis
- Discrete-time signals and systems
- Sampling theorem and reconstruction
- Z-transform and its properties

3: Digital Control Systems: Design and Analysis
- Transfer functions and block diagrams of digital control systems
- Design of digital controllers using Z-transform and frequency response methods
- Stability analysis of digital control systems

4: Implementation of Digital Control Systems
- Sampling and quantization effects on controller performance
- Digital signal processing techniques for controller implementation
- Realization of digital controllers using microprocessors and DSPs

5: State Space Modeling and Design of Digital Controllers
- State space representation of discrete-time systems
- State feedback and observer-based control design
- Digital controller design using state space methods

6: Nonlinear and Adaptive Control
- Nonlinear systems and their behaviour
- Design of digital controllers for nonlinear systems
- Introduction to adaptive control and its applications

7: Robust Control
- Uncertainty and disturbance models in control systems
- Design of robust digital controllers using H-infinity control
- Robust stability analysis of digital control systems

8: **Industrial Applications of Digital Control**
- Overview of industrial control systems and their requirements
- Digital control systems in power electronics, robotics, and process control
- Case studies of industrial applications of digital control

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Ogata, Katsuhiko. Modern Control Engineering, 6th Edition. Prentice Hall, 2019.
- Franklin, Gene F., et al. Feedback Control of Dynamic Systems, 8th Edition. Pearson, 2019.
- Åström, Karl Johan and Richard M. Murray. Feedback Systems: An Introduction for Scientists and Engineers, 2nd Edition. Princeton University Press, 2019.
- Dorf, Richard C. and Robert H. Bishop. Modern Control Systems, 13th Edition. Pearson, 2017.
- Phillips, Charles L. and Troy Nagle. Digital Control System Analysis and Design, 4th Edition. Pearson, 2015.

Network Security

Course outline

- Information and Network Security Overview
- (Information and Information Assets, Computer Security Concepts, CIA Triad, Active and Passive Attacks) Number Theory for Cryptography
  (Divisibility and the Division Algorithm, Greatest Common Divisor, The Euclidean Algorithm, Modular Arithmetic, Prime Numbers, Fermat's and Euler's Theorems, Discrete Logarithms)
- Classical Encryption Techniques (Cryptanalysis and Brute-Force Attack, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography)
- Symmetric Ciphers Stream and Block Ciphers, Feistel Cipher Structure, Data Encryption Standard (DES)

- Overview of Advanced Encryption Standard (AES) and Block Cipher *Modes*

Asymmetric Ciphers
(Public Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange

Cryptographic Data Integrity and Mutual Trust
(Cryptographic Hash Function, Secure Hash Algorithm (SHA), Message Authentication Codes, Digital Signature
Key Management and Distribution, Distribution of Public Keys, Public Key Infrastructure, User Authentication, Kerberos)

Secure Communication
(Securing Web Communications; TLS, Internet Protocol Security, Securing Wireless Networks)

Network and Internet Security
(Firewall Technologies, Intrusion Detection and Prevention Systems)

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Cryptography and Network Security, 7th Edition by William Stallings
- Principles of Information Security by Michael E. Whitman and Herbert J. Mattord

Network and System Programming

1: **Introduction to Network and System Programming**
- Overview of network and system programming
- Understanding networking protocols and socket programming
- Introduction to file handling and system calls

2: **Socket Programming**
- Socket programming basics and network communication
- Implementing client-server communication using sockets
- Multi-threading and concurrent socket programming

3: **Network Protocols and Packet Handling**
- Overview of network protocols and their functions
- Packet handling and manipulation using sockets
- Implementing network protocols using sockets

4: **Network Security and Encryption**
- Understanding network security and cryptography
- Implementing encryption and decryption using sockets
- Network security protocols like SSL/TLS

5: **File Handling and System Calls**

- Understanding file handling and system calls in operating systems
- Implementing system calls for file handling
- Implementing system calls for process management

6: Inter-Process Communication
- Inter-process communication techniques like pipes and message queues
- Shared memory and its implementation
- Synchronization mechanisms like mutex and semaphores

7: Network Programming with Python
- Introduction to Python socket programming
- Implementing networking protocols in Python
- Network security in Python

8: Advanced Network and System Programming
- Advanced topics like remote procedure call (RPC) and network file system (NFS)
- Overview of distributed systems and distributed programming
- Industry trends and real-world examples of network and system programming

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
1. Hall, Mark. Learn Systemd: A Beginner's Guide to Systems Programming, 2019.
2. Garg, Dheeraj. Mastering Linux Network Administration. Packet Publishing, 2020.
3. Fenner, William, et al. UNIX and Linux System Administration Handbook. Addison-Wesley, 2017.
4. Stevens, W. Richard, et al. TCP/IP Illustrated, Volume 1: The Protocols. Addison-Wesley, 2011.
5. Kurian, Jayakrishnan. Practical Network Programming with Rust, 2021.

Computer Organization

Course outline

- Introduction to computer Architecture (History of Computers)
- Von Neumann Architecture /Memory read/write processes / Machine cycle
- Clock cycle, Algorithmic state machine chart
- Data path architecture
- Memory hierarchy, registers and ALU Operations with Assembly
- Intel architecture
- Synchronous/Asynchronous buses, bus arbitration
- I/O interfacing with Assembly
- Cache, Types of cache, snoop, snarf, cache address mapping
- Dynamic and static RAMs

- I/O handling, I/O protocols
- Instruction set architecture, addressing modes with Assembly
- CISC and RISC comparison
- Pipelining, RISC pipelining, pipeline stalling
- Multicore processors
- RAID

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Computer Architecture and Organization by William Stallings

Computer Architecture

Course outline

1. Basics of Computer Architecture & I/O Devices
Introduction to computer architecture and organization, stored program concept / von Neumann architecture, system buses, CPU-memory interaction, memory organization, instruction cycle, machine cycles, instruction format, instruction types, instruction processing and execution sequence, performance measures, I/O handling and protocol, I/O modes (Programmed I/O, interrupt I/O).

2. MIPS Architecture and Assembly Language
Instruction set Architectures (ISA), MIPS instruction formats, MIPS addressing modes and memory architecture, introduction to assembly language programming, commonly used MIPS assembly instructions, translating high-level code to MIPS assembly.

3. Memory Hierarchy and Cache Organization
Introduction to memory hierarchy, cache basics, levels of cache, cache types, cache mapping (direct mapping, associative mapping, set associative mapping).

4. Pipelining
Basic concepts, MIPS pipeline, pipeline hazards.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
• Williams Stallings, Computer Architecture and Organization, 10e, Pearson, 2015.
• David A. Patterson and John L. Hennesy, Computer Organization and Design MIPS Edition: The Hardware/Software Interface, 6e, Morgan Kaufmann, 2020

Digital Systems Design

Course outline

- Basics of digital design – Introduction to digital design, Hardware vs Software Implementation, Device technologies, System representation & Levels of abstraction
- Revision of Digital Fundamentals – Combinational vs Sequential, Latch vs Flip-flop, Synchronous vs Asynchronous Signals etc.
- HDL background and basic VHDL constructs – HDL background, Skeleton of basic VHDL program, Data types and operators, Testbenches
- VHDL Dataflow (concurrent) and Sequential statements and combinational circuits description – Simple concurrent signal statements, Conditional concurrent signal statements, Selected concurrent signal statements, VHDL Process, Sequential statements, Latch Inference
- Sequential Circuit Design using VHDL – Basic synchronous circuit model, Basic Memory Elements – Latch, Flip-Flop, Inference of basic memory elements using VHDL, Shift Registers and Counters, Examples
- Timing Analysis, Resource Sharing & Pipelined Design –Timing Analysis Basics and D-FF Timing Parameters, Operator Sharing, Functionality Sharing, Pipeline Introduction, Delay vs Throughput, Examples
- Finite State Machine Design – Sequence Detectors, Mealy and Moore Machines, VHDL representations, ASM Charts, Examples
- RTL Design – Introduction, Basic RTL operations & their implementations, Examples
- Design Practices – Misuse of asynchronous signals, Misuse of gated clocks etc.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Pong P. Chu, RTL Hardware Design Using VHDL: Coding forEfficiency, Portability, and Scalability, Wiley-IEEE Press, 2006
- Digital Design: With a Introduction to the Verilog Hdl Book by M. Morris Mano and Michael D. Ciletti

Embedded Systems

Course outline

1. Introduction to Embedded Systems
• What is an Embedded System.
• Embedded Systems design constraints

2. PIC Microcontroller Architecture and Programming Model
• Microcontrollers vs Microprocessors
• Overview of PIC Microcontroller Family and Architecture
• PIC Programming Model
• PIC Instruction Set
• Examples

3. Interfacing PIC Microcontroller to the outside world
• I/O Interfacing basics
• PIC GPIO Module
• PIC Timers and Counters Module
• Watchdog Timer • Serial Communications basics
• PIC Serial Ports Module
• Interrupt Management
• PIC Interrupts Module
• PIC Capture-Compare Module
• Analog-To-Digital Conversion basics
• PIC Analog-To-Digital (A/D) Conversion Module
• SPI, I2C Communications Basics
• PIC SPI, I2C Module
• Examples

4. Model Based Design of Embedded Systems
• Embedded Systems Design Process
• Introduction to model-based design
• Context and Use Case diagrams
• Sequence and Collaboration diagrams
• Class and Object Diagrams
• State charts
• Examples and Case Studies

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Pong P. Chu, RTL Hardware Design Using VHDL: Coding forEfficiency, Portability, and Scalability, Wiley-IEEE Press, 2006
- Digital Design: With a Introduction to the Verilog Hdl Book by M. Morris Mano and Michael D. Ciletti

Unmanned Aerial Vehicles (UAVs)

1: Introduction to UAVs
- Overview of UAVs and their applications
- Classification of UAVs based on size, range, and endurance
- History and development of UAVs

2: UAV Platforms
- Types of UAV platforms: fixed-wing, rotary-wing, and hybrid
- Components of a UAV platform: airframe, propulsion system, avionics, and payloads
- Design considerations for UAV platforms

3: UAV Navigation and Control
- Overview of UAV navigation and control systems
- Autonomous and semi-autonomous control modes
- Sensors and communication systems for UAV navigation and control

4: UAV Sensors and Payloads
- Types of sensors used in UAVs: cameras, LiDAR, infrared, etc.
- Payloads used in UAVs: surveillance and reconnaissance, agriculture, disaster response, etc.
- Integration of sensors and payloads with UAVs

5: UAV Regulations and Ethics
- Overview of UAV regulations and policies in different countries
- Ethics of UAV usage: privacy, security, and safety concerns
- Legal and ethical issues related to UAVs

6: UAV Applications
- Overview of UAV applications in various industries: agriculture, construction, logistics, etc.
- Case studies of successful UAV applications
- Future of UAV applications

7: UAV Communication Networks
- Overview of UAV communication networks
- Communication protocols and standards for UAV networks
- Network topologies and routing algorithms for UAV networks

8: UAV Simulation and Testing
- Overview of UAV simulation and testing
- Tools and techniques for UAV simulation and testing
- Validation and verification of UAV systems

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
1. Keane, Thomas J. and Andriy Kryvokon. Drone Engineering: A Guide to Designing and Operating Small Unmanned Aircraft. Wiley, 2021.
2. Goodrum, Patrick M., et al. Unmanned Aircraft Systems: A Historical Perspective. Taylor & Francis, 2021.
3. McGeer, Tom. Unmanned Aerial Vehicles: Robotic Air Warfare 1917-2007. AIAA, 2020.
4. Pounds, Paul E. and Wade H. Sinclair. Drone Warfare: A Comprehensive Analysis of Weaponized Unmanned Aircraft. McFarland & Company, 2020.
5. Kim, Yunjun and Dongjun Lee. Unmanned Aerial Vehicle System Engineering: Technologies and Applications. CRC Press, 2020

Cloud Computing

Course outline

Introduction to cloud computing, Internet Architecture, APNIC, cloud service models, IaaS. PaaS,SaaS, Public,private, community and hybrid cloud ,Features of cloud model, issues/risk in cloud model ,basic cloud hardware requirements.

Virtualization concept, Hypervisor,Type1 and Type 2 hypervisor, Operating system vs processors based virtualization, Cloud high level connectivity diagram, cloud architecture, , Full/para /processor based virtualization, OS virtualization, AWS ,EC2 features

Hardware-assisted virtualization,VM migration, self ballooning,VM placement,Static, dynamic placement, Docker hub, client,server/daemon, image ,snapshot and start up commands, container concept ,control groups, docker run busybox, docker commands

Network virtualization, Overlay technology, OSI model, Network virtualization and security (NSX) functional and economical feature, VXLAN,VXLAN vs VLAN, SDN concepts

Cloud data center infrastructure, Risk factor of data center ,Cloud data Center design areas, Site selection.

DC Physical topology vsphere, VDC architecture, Vcenter,Vmotion, VM DRS ,VM-HA,Data center storage architecture, SAN, SAN Connectivity

Data center holding, staging area, UPS room, Meet me room, SHELL area, UPS,Generator room, service corridor, NOC, Raised floor,Data center grounding, EMF values and their effect,How to define N factor in data center design,Cloud data center cooling principal.

Google Authorization, ZANZIBAR research paper,ACL,Zanzibar implementation, Google authorization and consistancy in applications,Zanzibar deployment, Data center efficiency,Power usage effectiveness.

Data center monitoring, BMS,EMS,DCIM,NSM,MRTG, Observium tools, BMS protocol,SNMP, Observium demo lab

SLA ,OLA,MTTR,MTBF,response time, turn around time, What included in SLA docuemnt, SLA management,Force Majure works,Cloud SLA legal issues, Review cloud service SLA draft

PCI DSS introduction, PCI DSS objective, PCI DSS Goals,PCI DSS requirments,gap analysis, PCI DSS docurmentations, Term presentations

 Network security,DOS/DDOS attack,Phishing attack, SQL injection attack,DNS spoofing attack, TCP Syn attack, DDOS protection ,Attack prevention methods, Term presentations.

Hadoop architecture,HDFS,HDFS horizontal scalability, Data storage, Big data ,Map Reduce function,Map Reduce word count program

Mobile Internet Devices and the Cloud: Smartphones, Mobile Operating Systems for Smartphones, Mobile Platform Virtualization, Collaboration Applications for Mobile Platforms.IoT, Sensor node, a sink node, gateway,IoT application s,TESLA car,baby monitor application , www.Thinkspeak.com lab work, SN deployment

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Network virtualization for dummies by Mora Gozani , VMware Special Edition , Published by Wley
- Cloud Computing: Concepts, Technology & Architecture, by Ricardo Puttini, Thomas Erl, and Zaigham Mahmood.

- Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-06807.

- TIA 942 manual by TIA Published by TIA [For Data center standards]
- Data center certification manuals.
- Cloud Computing Bible by Barrie Sosinsky, Wiley; 1st Edition (2011). ISBN-10: 0470903562.

Cyber Security Systems

1: Introduction to Cyber Security
- Overview of cyber security and its importance
- Threats and vulnerabilities in cyberspace
- Types of cyber attacks and their impact

2: Network Security
- Network security protocols and standards
- Firewalls and intrusion detection systems
- Virtual private networks (VPNs) and secure sockets layer (SSL)

3: Cryptography
- Cryptographic algorithms and protocols
- Digital signatures and certificates
- Public key infrastructure (PKI)

4: Operating System Security
- Operating system security features and mechanisms
- User authentication and access control
- Malware detection and prevention

5: Web Security
- Web security protocols and standards
- Cross-site scripting (XSS) and cross-site request forgery (CSRF) attacks
- SQL injection and other web application vulnerabilities

6: Cloud Security
- Cloud security models and architectures
- Data protection and privacy in the cloud
- Cloud security challenges and solutions

7: Mobile Security
- Mobile security threats and vulnerabilities
- Mobile device management (MDM) and mobile application management (MAM)
- Secure coding practices for mobile applications

8: **Cyber Security Governance and Risk Management**
- Cyber security governance frameworks and standards
- Risk management and assessment methodologies
- Incident response and disaster recovery planning

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
1. Akhter, Shah M., et al. Cybersecurity: Attack and Defense Strategies, Second Edition. Packt Publishing, 2021.
2. Singh, Vipin. Cybersecurity: A Comprehensive Guide to Effective Defense. Apress, 2020.
3. Bhatt, Hemant and Varun Badhwar. Cybersecurity - Attack and Defense Strategies: Infrastructure security with Red Team and Blue Team tactics. Packt Publishing, 2020.
4. Chuvakin, Anton, et al. The Practice of Network Security Monitoring: Understanding Incident Detection and Response. No Starch Press, 2020.

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Geo-informatics

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1: Introduction to Geo-informatics
- Overview of Geo-informatics and its applications
- Basic concepts of GIS, Remote Sensing and GPS
- Hardware and software requirements for Geo-informatics

2: Geographic Information Systems (GIS)
- Introduction to GIS and its components
- Data types and models in GIS
- Data sources and acquisition methods in GIS

3: GIS Analysis and Visualization
- Spatial analysis techniques in GIS
- Data visualization and cartography in GIS
- Applications of GIS in urban planning, agriculture, and environmental management

4: Remote Sensing
- Introduction to remote sensing and its components
- Electromagnetic spectrum and its interaction with earth surface features
- Image processing and interpretation in remote sensing

5: Global Positioning System (GPS)
- Introduction to GPS and its components
- GPS surveying techniques and equipment
- Applications of GPS in navigation, surveying, and mapping

6: Geo-databases
- Introduction to geo-databases and their components
- Data modeling and design in geo-databases
- Querying and analysis of geo-databases

7: Web-based Geo-informatics
- Introduction to web-based Geo-informatics
- Development of web-based GIS applications
- Integration of Geo-informatics with other web technologies

8: Geo-informatics and Society
- Ethical and legal issues in Geo-informatics
- Role of Geo-informatics in disaster management and emergency response
- Future trends and developments in Geo-informatics

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
1. Longley, Paul A., et al. Geographic Information Science & Systems, 5th Edition. Wiley, 2021.
2. DeMers, Michael N. Fundamentals of Geographic Information Systems, 6th Edition. Wiley, 2021.
3. Jensen, John R. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Pearson, 2021.
4. Chang, Kang-tsung. Introduction to Geographic Information Systems, 9th Edition. McGraw Hill Education, 2020.
5. Korte, Monika and Dirk Tiede. GIS Basics, 4th Edition. Wichmann Verlag, 2022

Electrical vehicles Stream

Automotive Engineering

Course outline

Automotive Fundamentals:
The basic principles of automotive design, including vehicle systems and components.

Vehicle Dynamics:
The study of the forces acting on a vehicle and how they affect its motion, including suspension design, steering, and braking systems.

Powertrain Systems:
The design and development of powertrain systems, including engines, transmissions, and drivetrains.

Engine Design and Performance:
- The principles of internal combustion engines, their components, and their performance characteristics.

Automotive Electronics:
- The electronic systems used in modern automobiles, including sensors, actuators, and control systems.

Alternative Fuel Vehicles:
- The design and development of vehicles that use alternative fuels, such as electric, hybrid, and fuel cell vehicles.

Materials and Manufacturing:
- The materials used in automotive engineering, as well as the manufacturing processes used to produce automobiles.

Safety and Regulations:
- The safety standards and regulations that govern the automotive industry, including crash testing and emissions regulations.

Automotive Design and Styling:
- The aesthetic aspects of automotive design, including exterior and interior design, aerodynamics, and ergonomics.

Maintenance and Servicing:
- The maintenance and servicing of automobiles, including diagnostics, repair, and maintenance procedures.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Automotive Engineering: Powertrain, Chassis System and Vehicle Body by David Crolla
- Automotive Engineering Fundamentals by Richard Stone and Jeffrey K. Ball
- Automotive Engineering: Lightweight, Functional, and Novel Materials edited by Brian Cantor, P. Grant, and C. Johnston
- Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional HEV Technology by Xiaoqing Wei, Wei Liu, and Jianqiu Liang
- Automotive Engineering: Design for Manufacture by Tim Williams

EV Charging Devices and Technologies

Electric Vehicle Fundamentals:

The basic principles of electric vehicles, including their design, components, and operating principles.

EV Charging Station Design:

The design and development of electric vehicle charging stations, including site selection, layout, and installation.

EV Charging Standards and Protocols:

The various standards and protocols for electric vehicle charging, including AC and DC charging, charging rates, and communication protocols.

Charging Infrastructure and Management:

The development of charging infrastructure, including public charging stations, home charging stations, and network management systems.

Battery Technologies and Charging:

The design and development of batteries for electric vehicles, including charging technologies and safety considerations.

Renewable Energy Integration:

The integration of renewable energy sources with electric vehicle charging infrastructure, including solar and wind power.

Smart Grid Integration:

The integration of electric vehicle charging infrastructure with the smart grid, including demand response, load management, and grid stability considerations.

Business Models and Economics:

The economic and business aspects of electric vehicle charging, including pricing models, revenue streams, and financial analysis.

Environmental and Social Considerations:

The environmental and social impacts of electric vehicle charging, including carbon emissions, environmental impact assessments, and community engagement.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Electric Vehicle Charging for Smart Cities: A Practical Guide to Planning and Building Smart Electric Vehicle Infrastructure by David Thorpe
- Electric Vehicle Charging Technology and Standards by Zoran Stevic
- Electric Vehicle Charging Station Installation Guidelines: Residential and Commercial Locations by California Energy Commission
- Electric Vehicle Charging Systems: A Guide for Residential and Commercial Electric Vehicle Supply Equipment by United States Department of Energy
- Smart Grid Applications, Communications, and Security by Azzedine Boukerche
- Electric Vehicle Integration into Modern Power Networks by Andres Carvallo and John Cooper

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Sensors and Actuators

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Introduction to EV Sensors and Actuators:

The basic principles of sensors and actuators, and their role in electric vehicle systems.

Electric Motor Sensors:

The various sensors used in electric motors, including position, speed, and temperature sensors.

Battery Management System Sensors:

The sensors used in battery management systems, including voltage, current, and temperature sensors.

Chassis Control System Sensors:

The sensors used in chassis control systems, including wheel speed sensors, steering angle sensors, and brake pressure sensors.

Environmental Sensors:

The sensors used for environmental monitoring in electric vehicles, including temperature, humidity, and air quality sensors.

Power Electronics Sensors:

The sensors used in power electronics systems, including current sensors, voltage sensors, and temperature sensors.

Actuators for EVs:

The various types of actuators used in electric vehicles, including electric motors, solenoids, and valves.

Control Strategies for EV Sensors and Actuators:

The control strategies used for EV sensors and actuators, including feedback control, feedforward control, and model-based control.

Testing and Validation of EV Sensors and Actuators:

The testing and validation of EV sensors and actuators, including bench testing, simulation, and vehicle testing.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Sensors for Automotive Applications" by J. Paulo Davim:
- "Electric Vehicle Machines and Drives: Design, Analysis and Application" by Shaahin Filizadeh and Houman Zahedi:
- "Automotive Mechatronics: Operational and Practical Issues" by B. T. Fijalkowski and Dawid Majewski:
- "Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market" by Gianfranco Pistoia:
- "Handbook of Automotive Power Electronics and Motor Drives" by Ali Emadi:
- "Sensors and Actuators in Mechatronics: Design and Applications" by Andrzej M. Trzynadlowski:

EV Batteries and Ancillaries

Introduction to EV Batteries and Ancillaries:

The basic principles of EV batteries and ancillaries, and their role in electric vehicle systems.

Battery Technologies for EVs:

The various battery technologies used in electric vehicles, including lithium-ion, lead-acid, and nickel-metal hydride batteries.

Battery Management Systems:

The design and development of battery management systems (BMS) for electric vehicle batteries, including state-of-charge estimation, thermal management, and cell balancing.

Charging Infrastructure for EV Batteries:

The design and development of charging infrastructure for EV batteries, including charging stations, on-board chargers, and DC fast charging.

Battery Testing and Validation:

The testing and validation of EV batteries, including performance testing, safety testing, and life-cycle testing.

Power Electronics for EV Batteries:

The power electronics components used in electric vehicle batteries, including inverters, converters, and DC-DC converters.

Ancillary Components for EV Batteries:

The ancillary components used in electric vehicle batteries, including cooling systems, heating systems, and energy storage systems.

Battery Recycling and Second-Life Applications:

The recycling of EV batteries and second-life applications, including repurposing used batteries for stationary energy storage.

Regulatory and Safety Considerations:

The regulatory and safety considerations for EV batteries and ancillaries, including safety standards, regulations, and certifications.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Lithium-Ion Batteries: Science and Technologies" by Masaki Yoshio, Ralph J. Brodd, and Akiya Kozawa:
- "Battery Management Systems for Large Lithium Ion Battery Packs" by Davide Andrea and Kandler Smith:
- , Models, Sustainability, Infrastructure and the Market" by Gianfranco Pistoia:
- "Electric Vehicle Battery Systems" by Sandeep Dhameja:
- "Handbook of Electric Power Calculations" by H. Wayne Beaty and Surya Santoso

EV Software

Introduction to EV Software:

The basic principles of software systems used in electric vehicles, and their role in electric vehicle systems.

Embedded Software for EVs:

The design and development of embedded software for electric vehicle systems, including sensors and actuators, power electronics, and battery management systems.

EV Communication Protocols:

The communication protocols used in electric vehicle systems, including CAN bus, LIN bus, and Ethernet.

Software Development Process for EVs:

The software development process for electric vehicle systems, including requirements analysis, software design, coding, testing, and maintenance.

Software Tools for EV Development:

The software tools used for electric vehicle development, including simulation tools, rapid prototyping tools, and software testing tools.

Cybersecurity for EVs:

The cybersecurity considerations for electric vehicle software systems, including threat modelling, risk assessment, and security testing.

Autonomous Driving Software:

The software systems used in autonomous driving, including perception, decision-making, and control systems.

Cloud-based Software for EVs:

The cloud-based software systems used in electric vehicles, including over-the-air updates, data analytics, and remote diagnostics.

Regulatory and Safety Considerations:

The regulatory and safety considerations for electric vehicle software systems, including safety standards, regulations, and certifications

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach" by Amir Khajepour and M. Saber Fallah:
- "Electric Vehicle Technology Explained" by James Larminie and John Lowry:
- "Electric Vehicle Integration into Modern Power Networks" by João P. S. Catalão, Siddhartha Kumar Khaitan, and Pramod Agarwal:
- "Electric Vehicles: Design and Build Your Own" by Michael Hackleman:
- "Electric Vehicle Data Analytics for Smart Charging and Discharging" by Ali Emadi, Alireza Khaligh, and Zeyad T. Almutairi:
- "Electric Vehicle Machines and Drives: Design, Analysis and Application" by Shaahin Filizadeh and Houman Zahedi:

EV Control Systems

Introduction to EV Control Systems:

The basic principles of control systems used in electric vehicles, and their role in electric vehicle systems.

EV Powertrain Control:

The control systems used in electric vehicle powertrains, including motor control, power electronics control, and battery management control.

Vehicle Dynamics Control:

The control systems used for vehicle dynamics, including steering control, braking control, and suspension control.

Autonomous Vehicle Control:

The control systems used in autonomous vehicles, including perception, decision-making, and control systems.

Human-Machine Interface:

The design and development of human-machine interface (HMI) systems for electric vehicles, including displays, controls, and user feedback systems.

Energy Management Control:

The control systems used for energy management in electric vehicles, including energy storage system control, regenerative braking control, and energy consumption optimization.

Control System Design and Development:

The process of designing and developing control systems for electric vehicles, including system modelling, control algorithm design, and hardware-in-the-loop simulation.

Cybersecurity for EV Control Systems:

The cybersecurity considerations for electric vehicle control systems, including threat modelling, risk assessment, and security testing.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Electric and Hybrid Vehicles: Control Strategies" by Amir Khajepour, Kevin L. Johnson, and M. Saber Fallah:
- "Vehicle Dynamics and Control" by Rajesh Rajamani:
- "Advanced Control of Wheeled Inverted Pendulum Systems" by Alessandro De Luca, Giuseppe Oriolo, and Marilena Vendittelli:
- "Model Predictive Control of Automotive Powertrain Systems" by Uwe Kiencke and Lars Nielsen:
- "Electric Drive Control of EVs" by Seung-Ki Sul:

EV Integration with Power Grid

Introduction to EV Integration with Power Grid:

The basic principles of integrating electric vehicles with the power grid, and their role in the future of the energy system.

Charging Infrastructure:

The design and implementation of charging infrastructure for electric vehicles, including charging station types, charging protocols, and standards.

Power Electronics for EV Integration:

The power electronics used for integrating electric vehicles with the power grid, including bidirectional chargers, DC-DC converters, and inverters.

Vehicle-to-Grid (V2G) Systems:

The concept of vehicle-to-grid (V2G) systems, including the benefits, challenges, and applications of V2G technology.

EV Charging Management:

The management of EV charging, including scheduling, load balancing, and demand response.

Grid Management for EV Integration:

The management of the power grid to accommodate the integration of electric vehicles, including smart grid technology, grid stability, and energy management.

Energy Storage Systems:

The use of energy storage systems for EV integration with the power grid, including batteries, supercapacitors, and flywheels.

Cybersecurity for EV Integration:

The cybersecurity considerations for integrating electric vehicles with the power grid, including threat modelling, risk assessment, and security testing.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Electric Vehicle Integration into Modern Power Networks" by João P. S. Catalão, Siddhartha Kumar Khaitan, and Pramod Agarwal:
- "Electric Vehicles and Energy Storage Systems: A Sustainable Future" edited by Naser Mahdavi Tabatabaei, Masoumeh Haghbin, and Mir Sayed Shah Danishmand:
- "Plug-in Electric Vehicles: Smart Grid Integration" by Hua Bai:
- "Smart Grids and Electric Vehicles: Made for Each Other?" by Wilfried Aichholzer and Martina Liedermann:
- "Electric Vehicle Charging Infrastructure Planning, Design, and Deployment" by Mohamed Abdel-Monem El-Hawary:
- "Electric Vehicle Business Models: Global Perspectives" edited by Ralph E. H. Sims, Tilak K. Doshi, and David R. Shonnard:

Autonomous Vehicles

Introduction to Autonomous Vehicles:

The history and evolution of autonomous vehicle technology, as well as the current state of the industry.

Perception and Sensing:

The perception and sensing systems used in autonomous vehicles, including cameras, lidar, radar, and GPS.

Decision-Making and Planning:

The decision-making and planning algorithms used in autonomous vehicles, including path planning, obstacle avoidance, and decision-making under uncertainty.

Control Systems:

The control systems used in autonomous vehicles, including steering, braking, and acceleration.

Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communication:

The communication protocols and systems used for vehicle-to-vehicle and vehicle-to-infrastructure communication in autonomous vehicles.

Human-Machine Interface:

The design and development of human-machine interface (HMI) systems for autonomous vehicles, including displays, controls, and user feedback systems.

Cybersecurity for Autonomous Vehicles:

The cybersecurity considerations for autonomous vehicles, including threat modelling, risk assessment, and security testing.

Ethics and Policy Considerations:

The ethical and policy considerations for autonomous vehicles, including liability, privacy, and ethical decision-making.

Industry Applications:

The applications of autonomous vehicles in various industries, such as transportation, logistics, and agriculture.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Autonomous Vehicles: Intelligent Transport Systems and Smart Technologies" by Felipe Jimenez, Jaime Lloret, and Rafael Gadea:
- "Autonomous Driving: Technical, Legal and Social Aspects" edited by Markus Maurer, J. Christian Gerdes, Barbara Lenz, and Hermann Winner:
- "Autonomous Vehicle Navigation: From Behavioral to Hybrid Multi-Controller Architectures" by Alcherio Martinoli and Alessandro Giusti:
- "Autonomous Vehicles: Opportunities, Strategies, and Disruptions" by Evangelos Simoudis:
- "Reinforcement Learning for Autonomous Vehicles: A Survey" by Guillaume Lample and Devendra Singh Chaplot:
- "Robust and Adaptive Control for Autonomous Vehicles" by Andrey V. Savkin:

EV Circuits and Electronics

Introduction to EV Circuits and Electronics:

The basic principles of circuits and electronics in electric vehicles, and the importance of efficient and reliable electronics in electric vehicle design.

Power Electronics for EVs:

The power electronics used in electric vehicles, including DC-DC converters, inverters, and battery chargers.

Control Systems for EVs:

The control systems used in electric vehicles, including sensors, actuators, and control algorithms.

Battery Management Systems (BMS):

The design and implementation of battery management systems for electric vehicle batteries, including state-of-charge (SOC) estimation, balancing, and temperature control.

Electric Motors and Drives:

The electric motors and drives used in electric vehicles, including induction motors, permanent magnet motors, and motor controllers.

EV Charging Systems:

The design and implementation of charging systems for electric vehicles, including AC and DC charging stations, charging protocols, and standards.

EV Safety Systems:

The safety systems used in electric vehicles, including fuses, circuit breakers, and ground fault protection.

Electromagnetic Compatibility (EMC):

The design and implementation of electromagnetic compatibility (EMC) systems for electric vehicles, including electromagnetic interference (EMI) and radio frequency interference (RFI) mitigation.

Fault Diagnosis and Troubleshooting:

The techniques for fault diagnosis and troubleshooting in electric vehicle circuits and electronics.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Electric Vehicle Systems Architecture and Standardization Needs" edited by Massimo Cavazzini and Marco Picone:
- "Power Electronics for Electric and Hybrid Vehicles: Market Trends, Technologies, and Outlook" by Mario Paolone and Rachid Cherkaoui:
- "Electric Vehicle Batteries: Moving from Research towards Innovation" Gianfranco Pistoia and Boryann Liaw:
- "Electric Vehicle Technology for Construction, Agriculture and Off-Road Vehicles" by Markus Wagner and Juergen Fleischer:

EV Body and Chassis Design

Introduction to EV Body and Chassis Design:

The basic principles of body and chassis design for electric vehicles, and the importance of lightweight and aerodynamic design.

Vehicle Architecture:

The different types of vehicle architectures used in electric vehicles, including monocoque, spaceframe, and ladder frame.

Chassis Components:

The different components of the chassis, including suspension systems, steering systems, brakes, and wheels.

Body Design and Materials:

The design and materials used for the body of electric vehicles, including steel, aluminum, and composite materials.

Aerodynamics:

The principles of aerodynamics and their application to the design of electric vehicles, including drag reduction techniques and wind tunnel testing.

Crashworthiness and Safety:

The design and development of electric vehicles for crashworthiness and safety, including crash testing and safety regulations.

Vehicle Dynamics:

The principles of vehicle dynamics and their application to the design of electric vehicles, including handling and stability.

NVH (Noise, Vibration, and Harshness):

The principles of NVH and their application to the design of electric vehicles, including noise reduction techniques and vibration damping.

Manufacturing Processes:

The manufacturing processes used in the production of electric vehicle bodies and chassis, including stamping, welding, and bonding.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" by Iqbal Husain:
- "Electric Vehicle Design and Modeling: A Computational Approach" by Qiaoxing Li:
- "Electric Vehicle Integration into Modern Power Networks" by Saeid Mokhatab and William H. Kersting:
- "Vehicle Dynamics and Control" by Rajesh Rajamani:
- "Structural Composite Materials" by F. L. Matthews:

Vehicular Networking

Introduction to Vehicular Networking:

This topic covers the basics of vehicular networking, including the history, applications, and challenges associated with the field.

Wireless Communication:

This topic covers the various wireless communication technologies used in vehicular environments, including IEEE 802.11p, cellular networks, and ad hoc networks.

Intelligent Transportation Systems (ITS):

This topic covers the concepts and technologies involved in intelligent transportation systems, including traffic management, safety, and environmental sustainability.

Vehicular Ad Hoc Networks (VANETs):

This topic covers the architecture, protocols, and algorithms used in VANETs, including routing, security, and quality of service.

Vehicle-to-Vehicle (V2V) Communication:

This topic covers the communication between vehicles in a vehicular network, including the types of information exchanged, the communication protocols used, and the challenges associated with V2V communication.

Vehicle-to-Infrastructure (V2I) Communication:

This topic covers the communication between vehicles and infrastructure in a vehicular network, including the types of information exchanged, the communication protocols used, and the challenges associated with V2I communication.

Localization and Positioning:

This topic covers the methods and techniques used to determine the location and position of vehicles in a vehicular network, including GPS, dead reckoning, and map-based localization.

Security and Privacy:

This topic covers the security and privacy issues associated with vehicular networking, including authentication, access control, and privacy-preserving techniques.

Future Directions:

This topic covers the current trends and future directions in vehicular networking, including emerging technologies and research challenges.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- "Vehicular Networking: Automotive Applications and Beyond" by Jens Mittag and Bernd-Ludwig Wenning:
- "Vehicular Ad Hoc Networks: Standards, Solutions, and Research" edited by Christian Bonnet, Yannis P. Laberteaux, and Hao Zhu:
- "Connected Vehicles: Intelligent Transportation Systems and Smart Technologies" edited by Rajamani Ganeshan and V. Sridhar:
- "Automotive Ethernet: The Definitive Guide" by Kirsten Matheus and Thomas Königseder:
- "Vehicular Networks: Techniques, Standards, and Applications" edited by Uyen Trang Nguyen and Naveen Chilamkurti:

EV Dynamics

Introduction to EV Dynamics:

This topic covers the basics of EV dynamics, including the differences between conventional vehicles and electric vehicles, the fundamental principles of EV dynamics, and the types of electric vehicles.

EV Powertrain:

This topic covers the components of an electric vehicle powertrain, including the electric motor, battery, power electronics, and transmission system.

EV Modeling:

This topic covers the mathematical modeling of electric vehicles, including the modeling of the powertrain, tire-road interaction, and vehicle dynamics.

EV Control:

This topic covers the control of electric vehicles, including the design of controllers for the powertrain, regenerative braking, and stability control.

Battery Management System:

This topic covers the design and implementation of battery management systems for electric vehicles, including the monitoring of battery state-of-charge, state-of-health, and temperature.

Charging Infrastructure:

This topic covers the design and operation of EV charging infrastructure, including the different types of charging stations and the communication protocols used for charging.

Energy Management:

This topic covers the optimization of energy management in electric vehicles, including the design of energy-efficient driving strategies and the use of vehicle-to-grid (V2G) technology.

Simulation and Analysis:

This topic covers the simulation and analysis of electric vehicle dynamics using software tools, including MATLAB/Simulink, ANSYS, and AVL.

Future Directions:

This topic covers the current trends and future directions in EV dynamics, including emerging technologies and research challenges.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" by Iqbal Husain:
- "Electric Vehicle Dynamics and Control" by Haiping Du, Zongde Fang, and Wei Liu:
- "Advanced Electric Drive Vehicles" by Ali Emadi:
- "Automotive Electrification: Volume I - Electric Powertrains and Energy Storage Systems" edited by M. K. Khodayari and C. C. Chan:

Multi-Disciplinary Electives

Applied Mechanics

1. **Introduction**
   1. Definitions and scope of Applied Mechanics
   2. Concept of Rigid and Deformed Bodies
   3. Fundamental concepts and principles of mechanics: Newtonian Mechanics

2. **Basic Concept in Statics and Static Equilibrium**
   1. Concept of Particles and Free Body Diagram
   2. Physical meaning of Equilibrium and its essence in structural application
   3. Equation of Equilibrium in Two Dimension

3. **Forces acting on particle and rigid body**
   1. Different types of Forces: Point, Surface Traction and Body Forces - Translational Force and Rotational Force: Relevant Examples
   2. Resolution and Composition of Forces: Relevant Examples
   3. Principle of Transmissibility and Equivalent Forces: Relevant Examples
   4. Moments and couples: Relevant Examples
   5. Resolution of a Force into Forces and a Couple: Relevant Examples
   6. Resultant of Force and Moment for a System of Force: Examples

4. **Center of Gravity, Centroid and Moment of Inertia**
   1. Concepts and Calculation of Centre of Gravity and Centroid: Examples
   2. Calculation of Second Moment of Area / Moment of Inertia and Radius of Gyration and Relevant usages
   3. Use of Parallel axis Theorem: Relevant Examples

5. **Friction**
   1. Laws of Friction, Static and Dynamic Coefficient of Friction, Angle of Friction: Engineering Examples of usage of friction
   2. Calculations involving friction in structures: Example as High Tension Friction Grip bolts and its free body diagram

6. **Analysis of Beams and Frames**
   1. Introduction to Structures: Discrete and Continuum
   2. Concept of Load Estimating and Support Idealizations: Examples and Standard symbols
   3. Use of beams/frames in engineering: Concept of rigid joints/distribute loads in beams/frames.
   4. Concept of Statically/Kinematically Determinate and Indeterminate Beams and Frames: Relevant Examples
   5. Calculation of Axial Force, Shear Force and Bending Moment for Determinate Beams and Frames
   6. Axial Force, Shear Force and Bending Moment Diagrams and Examples for drawing it.

7. **Analysis of Plane Trusses**
   1. Use of trusses in engineering: Concept of pin joints/joint loads in trusses.
   2. Calculation of Member Forces of Truss by method of joints: Simple Examples
   3. Calculation of Member Forces of Truss by method of sections: Simple Examples

8. **Kinematics of Particles and Rigid Body**
   1. Rectilinear Kinematics: Continuous Motion
   2. Position, Velocity and Acceleration of a Particle and Rigid Body
   3. Determination of Motion of Particle and Rigid Body
   4. Uniform Rectilinear Motion of Particles
   5. Uniformly Accelerated Rectilinear Motion of Particles
   6. Curvilinear Motion: Rectangular Components with Examples of Particles

9. **Kinetics of Particles and Rigid Body: Force and Acceleration**
   - Newton's Second Law of Motion and momentum
   - Equation of Motion and Dynamic Equilibrium: Relevant Examples
   - Angular Momentum and Rate of Change
   - Equation of Motion-Rectilinear and Curvilinear
   - Rectangular: Tangential and Normal Components and Polar Coordinates: Radial and Transverse Components

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- "Mechanics of Engineers- Statics and Dynamics", F.P. Beer and E.R.Johnston, Jr. 4th Edition, Mc Graw-Hill, 1987.
- "Engineering Mechanics-Statics and Dynamics", R.C. Hibbeler, Ashok Gupta. 11th edition., New Delhi, Pearson, 2009.
- "Engineering Mechanics- Statics and Dynamics", I.C. Jong and B.G. Rogers
- "Engineering Mechanics- Statics and Dynamics", D.K. Anand and P.F. Cunnif
- "A Text Book of Engineering Mechanics", R.S. Khurmi
- "Applied Mechanics and Strength of Materials", R.S.Khurmi
- "A Text Book of Applied Mechanics", I.B.Prasad
- "Engineering Mechanics-Statics and Dynamics", Shame, I.H. 3rd ed., New Delhi, Prentice Hall of India, 1990

Fluid Mechanics

Course Outline:

Introduction and properties of Fluid
Properties of Fluid, viscosity, surface tension, vapor pressure and cavitation, Classification of Fluid flow.

Fluid Statics
Center of pressure, Hydrostatic forces on submerged surfaces, Buoyancy and stability.

Fluid Dynamics
Velocity and acceleration field, Static, dynamic and stagnation pressure, Bernoulli's equation; Energy equation for steady and incompressible flow, laminar and turbulent flow in circular pipes; Hydraulic losses and correction factor, Introduction of Dimensional Analysis.

Governing Equations of Fluid Flow
Eulerian and Lagrangian viewpoints; Continuity equation, Navier-Stokes Equation, Reynold's Transport theorem for continuity, linear momentum and Angular Momentum.

Potential flow theory
Irrotational flow field; stream function, velocity potential function, vorticity and circulation relation, basic potential flows; uniform flow; two dimensional source and sink; simple vortex; the doublet; lift and drag forces.

Boundary Layer Theory
Boundary layer theory; laminar boundary layer; turbulent boundary layer, boundary layer thicknesses; drag, lift and airfoil cascades.

Fluid Machinery
Euler's equation of turbo-machine, classification of turbo-machines; centrifugal pumps and turbines, affinity laws, specific speed, performance curves

Teaching Methodology (Proposed as applicable)

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg. disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Exam, Final Exam, Quizzes, Assignments, Presentation

Suggested books:

- Munson, "Fundamentals of Fluid Mechanics", John Wiley, 2014
- Frank M, "Fluid Mechanics", McGraw-Hill India, 2017
- Çengel, "Fluid Mechanics-Fundamentals and Applications", McGraw-Hill, 2018
- Robert W. Fox, "Introduction to Fluid Mechanics", Wiley, 2016
- Joseph Katz, "Introduction to Fluid Mechanics", Cambridge University Press, 2010

Thermodynamics

Course Outline:

Introduction to Thermodynamics
Concept of Equilibrium, Continuum, Pressure and Temperature; Zeroth Law of Thermodynamics, Properties of Pure Substances, PVT surfaces, Use of steam table, conservation of mass, pressure and temperature measurement devices.
Equation of state

Ideal gas law, Vander Wall equation, Law of corresponding states, Virial equation of state.

Laws of Thermodynamics
Work, Heat, Law of conservation of Energy, First law of thermodynamics for closed and open system, Second law of thermodynamics, Heat engine, Refrigeration and heat pump, Carnot Cycle, Entropy, Clausius Inequality, Isentropic relations, Thermodynamic process and cycles. Introductory concept of Mechanical Exergy.

Thermodynamic Power Cycles
Thermal Efficiency, Air standard Otto, Diesel and Dual Cycle; Brayton Cycle, Rankine Cycle.

Reciprocating Compressors:
Condition for minimum work; isothermal efficiency; volumetric efficiency; multi-stage compression; energy balance for a two stage machine with intercooler.

Teaching Methodology (Proposed as applicable)

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg. disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Exam, Final Exam, Quizzes, Assignments, Presentation

Suggested books:

- Cengel, "Engineering Thermodynamics", McGraw-Hill, 2019
- Moran Shapiro, "Fundamentals of Engineering Thermodynamics", Wiley, 2019.
- Yunus A. Çengel, "Fundamental of Thermal-Fluid Sciences", McGrawHill, 2016.

Surveying & Leveling

Course Outline:

- ● Fundamental Concepts: Definitions, uses & types of surveys, survey measurements, errors and adjustments. Basic Survey Measurements: Distance measurements, levelling, different methods & types of instruments, angle and direction measurement & construction and adjustment of transit & compass, theory, practical and use of stadia surveying.

- ● Surveying Operation: Plane table traverse - Transit tape traverse, triangulation adjustment of traverse and triangulation network, construction & use of optical alidade, precise measurement of baseline location of details and area measurement, determination of meridian by astronomical observation, topographic maps.

- ● Mine Surveying: Transfer of co-ordinates level and meridian underground, use of auxiliary telescope, laying out of curves, special mine surveying.

- ● Field Work: Levelling traversing with plane table and transit-tape traversing, triangulation network practice, survey camp of at least two weeks duration to prepare topographic map.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final term

Suggested Books

- Davis and Foote. 1968. Surveying, McGraw-Hill.
- Kanetker, T.P. 1996. Surveying and Levelling. Vol.1&2.
- Staley W.W. 1964. Introduction to Mine Surveying, Stanford University Press.
- Brinker, R.C. 1997. The Surveying Handbook, CBS Publishers and Distributors.
- Abid, S.H. 2000. Mine Surveying. Ministry of Education, Pakistan

Environmental Engineering

Course Contents:

- **Basic Concepts:** Introduction to environment and ecology, pollution concept, types of pollution. Environmental national and international policy and standards;
- **Environmental Monitoring (gas, liquid, solids):** Sampling and monitoring mechanism, Design and types of samples, Pre-sampling requirements/ information, sampling and design purposes.
- **Pollution Control and Treatment Techniques:** Air pollution control technologies, water pollution control technologies, water treatment technologies, sub-soil / soil pollution control technologies, noise pollution control technologies. Biotechnology for environment, industrial pollution control; covering design, sizing and operation.

- **Climate Change**

  Global warming and climate change, Different Weathers, Earth's climate system, types and influencing Factors, Green house effect, Energy use and carbon emissions, Effect and Importance of climate on environment , Impacts of climate changes on human life and environment, History and data analysis of climate changes, Controls of climate changes, UNO action plan of climate changes.

- **Assessment Techniques:** Principles and purposes of IEE and EIA and its significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. EIA methods and techniques for impact prediction and evaluation

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- Cheremisinoff Handbook of Air Pollution Prevention and Control, 2002

Software Engineering

Course Outline:
- Overview of Software Engineering
- Professional software development
- Software engineering practice
- Software process structure
- Software process models
- Agile software Development, Agile process models
- Agile development techniques
- Requirements engineering process
- Functional and non-functional requirements
- Context models, Interaction models, Structural models, behavioral models
- Model driven engineering
- Architectural design
- Design and implementation
- UML diagrams
- Design patterns
- Software testing and quality assurance, Software evolution
- Project management and project planning
- Configuration management, Software Process improvement

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg
disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Software Engineering: A Practitioner's Approach by Pressman, Roger S. and Bruce Maxim, latest Edition, McGraw Hill.
- Software Engineering by Sommerville, latest Edition, Pearson Education

Bio-Mechanics

Course Outline:
1. Introduction
  a. Definition and perspective
  b. Review of statics
  c. Review of Dynamics
  d. Review of deformable body mechanics
  e. Viscoelasticity, material properties 75
2. Anthropometry
  a. Density, mass and inertial properties
  b. Direct measurement of anthropometric parameters

    c. Muscle anthropometry

    d. Mechanical advantage of muscle

    e. Multipoint muscles,

3. Kinematics of Human Movement

    a. Forms of motion

    b. Standard reference systems and joint movement terminology

    c. Spatial reference systems

    d. qualitative vs. quantitative analysis of human movement

    e. limb-segment angles, joint angle, linear and angular velocities and acceleration f. tools for direct/indirect measurement of kinematic quantities

4. The biomechanics of Human Bone Growth and Development

    a. Composition and Structure of Bone Tissue

    b. Material Constituents

    c. Structural Organization

    d. Types of Bones

    e. Bone Growth and Development

    f. Longitudinal Growth

    g. Circumferential Growth

    h. Adult Bone Development

    i. Bone Response to Stress

    j. Bone Modeling and Remodeling

    k. Bone Hypertrophy

    l. Bone Atrophy

    m. Osteoporosis

5. Kinetics of Human Movement

    a. Link segment models

    b. Joint reaction forces

    c. Direct Force measurements

    6. Biomechanics of upper & lower extremity

    a. Loading and injuries to the shoulder, elbow, wrist joints.

    b. Loading and injuries to the Hip, knee and ankle joints

7. Gait Biomechanics

    a. Methods of gait analysis

    b. Gait cycle

    c. Temporal-spatial parameters

    d. Hip, knee and ankle joint kinematics and kinetics

    e. Interpretation of gait data

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg

disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

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

Optimization Techniques

Course Outline:

Introduction to Optimization
Statement of optimization, Objective function, Problem constraints and constraint surface, Classification of optimization problems

Linear Programming
Variants of linear programming, examples of linear programming problems, linear algebra background, graphical representation for two dimensional space

Geometry Linear Programming
Polyhedra and convex sets, extreme points, vertices, existence of extreme points, optimality of extreme points

Simplex Algorithm
Optimality conditions, identifying an optimal point, development of simplex algorithm, two phases of simplex algorithm, column geometry of simplex algorithm, computational complexity of simplex algorithm

Duality Theory
Duality in linear programming, primal-dual relations, duality theorem, dual simplex method, optimal dual variables

Nonlinear Optimization
Least-squares & linear optimization, Nonlinear optimization, Convex optimization

Convex Sets
Affine and convex sets, convexity preserving operations, separating and supporting hyper-planes, generalized inequalities

Convex Functions
Operations preserving convexity, conjugate function, Quasi-convex functions, Log-concave and log-convex functions, Convexity with respect to generalized inequalities

Convex Optimization

Convex optimization problems, quadratic optimization, geometric optimization, Duality, Lagrange dual function, dual problem, geometric interpretation, optimality conditions,

Algorithms
- Unconstrained problems,
- equality constrained problems
- Interior Points method

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg
disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Introduction to Linear Optimization by Dimitris Bertsimas & John N. Tsitsiklis, Athena Scientific 1997.
- Convex Optimization by S. Boyd & L. Vandenberghe Cambridge Univ. Press, 2004
- Engineering Optimization: Theory and Practice by S. S. Rao , John Wiley & Sons 2009

Occupational Health and Safety

Course Description:

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home. Learning Outcomes: Upon successful completion of this course, the student will be able to:

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

- Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
- Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
- Present a coherent analysis of a potential safety or health hazard both verbally and in writing, citing the Ontario Occupational Health and Safety Regulations as well as supported legislation.
- Demonstrate a comprehension of the changes created by WHMIS and OSHA legislation in everyday life.

Course Outline:

Health and Safety Foundations:
- Nature and scope of health and safety
- Reasons/benefits and barriers for good practices of health and safety
- Legal frame work and OHS Management System

Fostering a Safety Culture:
- Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)
- Re-thinking safety-learning from incidents
- Safety ethics and rules
- Roles and responsibilities towards safety
- Building positive attitude towards safety
- Safety cultures in academic institutions

Recognizing and Communicating Hazards:
- Hazards and Risk
- Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and lifting etc
- Learning the language of safety: Signs, symbols and labels Finding Hazard Information
- Material safety data sheets
- Safety data sheets and the GHS (Globally Harmonized Systems)

Accidents & Their Effect on Industry
- Costs of accidents
- Time lost
- Work injuries, parts of the body injured on the job
- Chemical burn injuries
- Construction injuries
- Fire injuries

Assessing and Minimizing the Risks from Hazards
- Risk Concept and Terminology
- Risk assessment procedure
- Risk Metric's
- Risk Estimation and Acceptability Criteria
- Principles of risk prevention
- Selection and implementation of appropriate Risk controls
- Hierarchy of controls

Preparing for Emergency Response Procedures
- Fire
- Chemical Spill
- First Aid
- Safety Drills / Trainings:
    - o Firefighting
    - o Evacuation in case of emergency

Stress and Safety at Work Environment
- Workplace stress and sources
- Human reaction to workplace stress
- Measurement of workplace stress
- Shift work, stress and safety
- Improving safety by reducing stress
- Stress in safety managers
- Stress and workers compensation

Incident Investigation
- Importance of investigation
- Recording and reporting
- Techniques of investigation
- Monitoring
- Review
- Auditing Health and Safety

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg
disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- The A-Z of health and safety by Jeremy Stranks, 2006.
- The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.
- Occupational safety and health law handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

12.2 Non-Engineering Domain

English Courses

Functional English

Area Scope:

The knowledge units in this area collectively encompass the following:

- Follow English vocabulary and skills to use it in professional life.
- Identify common errors usually made by the Learners of English as second language
- Practice English correctly in speaking and writing

Course Outline:

- Public Speaking
- The Art of Creating a Power Point Presentation.
- Interacting with the Opposite Gender
- Classroom Etiquettes and Teachers' Expectations
- Articles:
- Prepositions.
- Homophones:
- Punctuation
- Tenses in English Grammar
- Formal Letter Writing
- Summary writing
- Organizing and planning your writing
- Sensory Perception in writing.
- Critical thinking
- Final Term Project

Teaching Methodology (Proposed as applicable):

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Project / Field Visits, Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engg Project

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):

- P. C. Wren & H. Martin "High School English Grammar & Composition".
- Colin W. Davis & Andrew J. Watts New Expressway For English 1 (New Edition)
- Hert A. Murphy & Herbert William Hildebrandt. Effective Business Communications
- Diana Hacker. A Writer's Reference
- Sadat Ali Shah. Exploring The World Of English
- A. J. Thomson and A. V. Martinet. Practical English Grammar,"University Physics", 13th Edition

Communications and Presentation Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

- Communicate effectively using intermediate- to-advanced level English while developing the understanding of essentials of communication skills.
- Participate in group discussions by attentive listening, questioning to clarify ideas, eliciting responses, or disagreeing in a constructive way.

Course Outline:

By the end of the semester students will have skills including:

- **Writing Skills**
  a. Vocabulary Building
  b. Writing Skills: Essays and Letters
  c. Common Writing Errors
  d. Purposeful Writing
- **Reading Skills**
  a. Skimming and Scanning
  b. Critical Reading
  c. Reading for Understanding
  d. Techniques and strategies to develop sound vocabulary.
- **Listening Skills**
  a. Introduction to Communication Process
  b. Seven Cs of Communication
  c. Types of Listening
  d. Listening for Comprehension
- **Speaking Skills**
  a. Verbal and Non-Verbal Communication
  b. Basics of Presentation Skills
  c. Presentation Strategies and public speaking skills.
  d. Use of Audio-Visual Aids
  e. Basics of Group Communication
  f. Listening Skills
  g. Communicate effectively in job interviews.

- Presenting and publishing research

Teaching Methodology (Proposed as applicable):

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Project / Field Visits, Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engg Project

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books (latest edition):
- Anchor in English-II (Lessons 1-5), A SPELT Publication
- Christopher Fry, "Summary Writing (Book-I)", Oxford University Press
- College Essays by John Langlan
- Barron's TOFFL iBT Edition
- Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
- Writing for Computer science by Justin Zobel Research Methodologies – A step by step guide for beginners, Ranjit Kumar.

Islamic Studies and Ethics

Course outline:

Introduction to Quranic Studies

- Basic Concepts of Quran
- History of Quran
- Uloom-ul-Quran

Study of Selected Text of Holy Quran

- Verses of Surah Al-Baqara Related to Faith(Verse No-284-286)
- Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

Study of Selected Text of Holy Quran

- Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6, 21, 40, 56, 57, 58.)
- Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No1,14)

Seerat of Holy Prophet (S.A.W) I

- Life of Muhammad Bin Abdullah (Before Prophet Hood)
- Life of Holy Prophet (S.A.W) in Makkah
- Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

- Life of Holy Prophet (S.A.W) in Madina
- Important Events of Life Holy Prophet in Madina
- Important Lessons Derived from the life of Holy Prophet in Madina

Introduction to Sunnah

- Basic Concepts of Hadith
- History of Hadith
- Kinds of Hadith
- Uloom –ul-Hadith
- Sunnah & Hadith
- Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence
- Basic Concepts of Islamic Law & Jurisprudence
- History & Importance of Islamic Law & Jurisprudence
- Sources of Islamic Law & Jurisprudence
- Nature of Differences in Islamic Law
- Islam and Sectarianism

Islamic Culture & Civilization
- Basic Concepts of Islamic Culture & Civilization
- Historical Development of Islamic Culture & Civilization
- Characteristics of Islamic Culture & Civilization
- Islamic Culture & Civilization and Contemporary Issues

Islam & Science
- Basic Concepts of Islam & Science
- Contributions of Muslims in the Development of Science
- Quran & Science

Islamic Economic System
- Basic Concepts of Islamic Economic System
- Means of Distribution of wealth in Islamic Economics
- Islamic Concept of Riba
- Islamic Ways of Trade & Commerce

Political System of Islam
- Basic Concepts of Islamic Political System
- Islamic Concept of Sovereignty
- Basic Institutions of Govt. in Islam

Islamic History
- Period of Khilaft-E-Rashida
- Period of Ummayyads
- Period of Abbasids

Social System of Islam
- Basic Concepts of Social System of Islam
- Elements of Family
- Ethical Values of Islam

Suggested Books:

- Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
- Hameed ullah Muhammad, "Muslim Conduct of State"
- Hameed ullah Muhammad, 'Introduction to Islam
- Mulana Muhammad Yousaf Islahi,"
- Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- H. S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)

Pakistan Studies and Global Perspective

Course outline

- **Historical and ideological perspective of Pakistan Movement**

  a. Evolution of the concept of Nation and Nationalism in the sub-continent: Two Nation Theory
  b. Sir Syed Ahmed Khan: Aligarh Movement
  c. Factors leading to the creation of Pakistan.
  d. Allama Iqbal and the idea of Pakistan
  e. Quaid-e-Azam and the demand of Pakistan.

- **Pakistan – the Land of Opportunities**

  a. Physical features: diversity and beauty
  b. Geo-political and strategic significance of Pakistan in regional and global politics
  c. Natural resources: mineral, water and power.
  d. Tourism and culture

- **Constitutional Process**

  a. An overview of constitutional development in Pakistan
  b. Constitutional and political crisis of 1971.
  c. Salient features of the constitution of 1973
  d. Constitutional amendments

- **Economy of Pakistan**

  a. A brief survey of Pakistan Economy
  b. **Role of industries for sustainable development**
  c. An overview of current economic situation in Pakistan; problems, issues and future prospects.
  d. Science and technology innovation profile of Pakistan (STI profile)
  e. Role CPEC in Economic Development

- **Pakistan's Foreign Policy**

  a. Pakistan Relations with neighbors
  b. Major powers
  c. Muslim world.

- **Contemporary Pakistan**

  a. **Pakistan's society and culture: role of engineers**
  b. Nation-building in Pakistan
  c. **Characteristics of good citizens of Pakistan**
  d. Low literacy rate: problem, issue and solution
  e. **Fundamental Rights of the citizens of Pakistan**
  f. **Environmental pollution: causes, hazards and solution**

Teaching Methodology (Proposed as applicable)

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term.
Suggested Books

- Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960
- Gulam Allana, Quaid-e-Azam: the story of Pakistan, Ferozsons, 1967.
- Shahid M. Amin, Pakistan's Foreign Policy: A Reappraisal, Oxford University Press, 2010.
- S. Akbar Zaidi, Issues in Pakistan's economy, Oxford University Press, 2003.
- Hamid Khan, Constitutional & political history of Pakistan, Oxford University Press, 2003
- Rafi Raza, *Pakistan in Perspective 1947-1997*, Oxford University Press, 2003
- Sharif-ul-Mujahid, *The Ideology of Pakistan* , Progressive Publishers, 1974.
- Ziring Lawrence, *Pakistan in the Twentieth Century,* Oxford University Press, 1997 -
- Burke S. M. & Ziring Lawrence, *Pakistan's Foreign Policy,* Oxford University Press, 1973.
- Mohammad Qadeer , Pakistan - Social and Cultural Transformations in a Muslim Nation, Routledge, 2006.

Professional Ethics

Course Outline

- Engineering Ethics, Ethical concepts, and Types
- Moral Autonomy, Kohlberg's & Gilligan's Theory
- Profession and Professionalism
- Moral Reasoning, Ethical Theories
- Critique codes of ethics
- Moral frameworks, Personal commitments and professional life
- Engineering as social experimentation
- Involving the public in the design process, Case studies for engineering as social experimentation
- Assessment of safety and risk, Design considerations, uncertainty
- Risk-benefit analysis, Safe-exit and fail safe systems

- Case Studies for the Design Process Case studies in impact of safety/risk on design
- Employee/employer rights and responsibilities
- Confidentiality and conflict of interest
- Whistle-blowing, case studies on professional behavior/policies on the job
- Environment, sustainable development, Multinational corporations, globalization of engineering

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Ethics in Engineering 4th edition, by Mike W. Martin, Roland Schinzinger, McGrawHill, New York, 2005.
- Fundamentals of Engineering Economics, 3rd ed., by Chan S. Park
- Engineering Ethics: Concepts and Cases,4th edition, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, 2008
- The Seven Habits of Highly effective people by Stephan r. Covey
- Principle Centered Leadership Stephan r. Covey
- Change your lens change your life by (Faiez H. Seyal)
- How to Manage by Ray Wild
- Happiness by Richard Layard

Sociology for Engineers

Course outline

- **Fundamental Concepts and Importance of Sociology for Engineers**
What is sociology? Nature, Scope, and Importance of Sociology, Sociological Perspectives and Theories, Social Interactions, Social Groups/ Social Institutions & heir interface with Engineering Project/services, Sociology & Impact of Technology & Engineering Products/Projects on Society
- **Cultural Impacts of Engineering Projects on Society**
Definition of Culture, Types of Culture & Elements of Culture, Culture & Power, Authority, Dominance Socialization and Personality, Role of Engineering Projects on Culture, social norms and values of Society, Cultural Infusion of Engineers in Society
- **Theoretical Perspective of Sociology:**
Diffusion and Innovation; Adoption and Adaptation; Social development; Community Development Community Development & Social consequences of Industrialization, Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context

- **Understanding of Societal & Ethical Norms and Values for Engineers**

 Engineering Ethics, Engineering product/services for Less privileged, Role of Engg & Technology in addressing Social inequality, Core Social Values/Norms affecting Engg Performance

- **Organizational Social Responsibility (OSR) of Engineers**

Extenttowhichdevelopmentintendstosensitizesocietalandunder-privileged needs; Gender inclusiveness and balance; Special and Disadvantaged Community of the Area; Planning for community inclusiveness; Societal Obligation of Engineers

- **Engineers, Society and Sustainability**

Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.

- **Industrial & Organizational Psychology**

Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity

- **Climate Change and Ecological Friendliness from Engineering Perspective**

Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc).

- **Social Approaches and Methodologies for Development Administration & Stakeholders Analysis**

All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.

- **SIA (Social Impact Assessment):**

Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective Behavior, Social Audit of Engineering Projects.

- **Engineering Intervention for Social Stratification**. Factors of Social Stratification, Engineering Interventions for addressing Social Stratification, Social Mobilization through Technological Innovation.

- **Case Studies of Different Development Projects in Social Context**

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Latest edition.
- Nichols, S. P. and Weldon, W. F. latest edition. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
- Aslaksen, E. W. latest edition. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales, latest edition. Gumbooya Pty Lte, Allambie Heights, Australia

- Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers, latest edition • Jamison, A., Christensen, S. H., and Lars, B. latest edition. A Hybrid Imagination: Science and Technology in Cultural Perspective.
- Vermaas, P., Kroes, P., Poet, l., and Houkes, W. latest edition. A Philosophy of Technology: From Technical Artefacts to Socio technical systems.
- Mitcham, C., and Munoz, D. Humanitarian Engineering. Morgan and Claypool Publishers, latest edition
- Riley, D. Engineering and Social Justice. Morgan and Claypool Publishers.
- Bugliarello, G. latest edition. The Social Functions of Engineering: A Current Assessment, A Chapter in"Engineering as A Social Enterprise

Critical Thinking

Course outline

• Introduction

Introduction to the Fundamentals of Critical Thinking. Why Critical Thinking Matters?
Critical Thinking and the Process of Analysis; A. Teaching Students to Think Theoretically
B. Teaching Students to Think Empirically

• Strategies and Techniques to develop critical Thinking

Brain Storming, Concept Mapping, Generalization and Testing the Limits, Venn Diagram, Logical Reasoning

• Critical Thinking and Art of Questioning

Critical Thinking and Socratic Questioning; Teaching Students to Ask Good Questions & Follow up the Implications of Thought; Teaching Students to narrate, analyze, and evaluate their own 'Points'; View' and of others; Open and Close ended Questions

• Critical Thinking and its Applications

Interrogating the Text; Primary and Secondary Sources; Characteristics of Academic Text; Status of Evidence; Status of The Author; Comparing and Contrasting Different Source

• Introduction to Reflection

Meaning of reflection on practice/educational issues; Significance of reflection for teacher

- **Major Proponents of Reflective Practice**

John Dewey; L. Stanhouse; D,Schon

- **Process and Techniques of Reflection**

Process of reflection; Major techniques and strategies (critical incident analysis, keeping reflective journals, peer coaching, action research); Skills for reflection

- **Application of skills and approaches to reflection**

Systematic reflection throughout the coursework; Identify key questions for their own role as novice teachers; Understand the issues in becoming a reflective practitioner;

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Recommended Books:

- Ayoukarm, Govald (1989), Modern Methods and Techniques of Teachings Philadephia. Open University press 1
- Baron, J. and Sternberg, R, (Eds.) (1987) Teaching thinking skills: theory and practice, New York: Freeman.
- Barrow, R. (1990) Understanding Skills: Thinking, Feeling and Caring. London, Ontario: Althouse.
- Beyer. B. K. (1987) Practical strategies for the teaching of thinking. Boston: Allyn and Bacon.
- Chipman, S., Segat, J. and GIaser, R, (1985) Thinking and Learning Skills, Volume 2. Research and Open Questions. HiNsdale, New Jersey: Eribaum.
- Costa, A.L. and Lowery, L.F. (1990) Techniques for teaching thinking, Melbourne: Hawker Brownlow. Finn, B. (1991) Young People's Participation in Post-compulsory Education and Training. Report of the Australian Education Council Review Committee. Canberra: Australian Government Publishing Service

Organizational Behavior

Course outline

- **Introduction to Organizational Behavior**

Organizational Disciplines and topics; Psychological Perspective; Social-Psychological Perspectives

- **Structure and Control in Organization**

Introduction of Bureaucracy; Managerial Work; Contingency theory; Organizational Design

- **Individual and Work Learning**

Learning Theories; Learning and Work

- **Stress**

Types of Stress and Work; Occupational Stress Management

- **Individual Differences**

Personality and its factors; Personality dimensions and social learning Intelligence

- **Motivation and Job Satisfaction**

Needs at Work; Theories of Motivation and job satisfaction; Correlates of Job satisfaction; Correlates of Job satisfaction

- **Group and Work**

Social Interaction; Dramaturgy and impression Management; Social Skill

- **Group and Inter Group Behavior**

Group Structure & Norms; Group Processes; How throne Studies

- **Leadership**

Leadership as an attribute; Leadership Style

- **Patterns of Work**

Work-the classical approach; Marx, Weber, & The critique of labor; Foucault & Disciplinary Power; Conflict and Consent in Work; The labor Process debate; Work place control and resistance; Industrial conflict and industrial relations

- **Organizational culture**

Organizational culture and strategic management; Exploring organizational culture; Evaluating concept of culture

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Finchan, R., & Rhodes, P. latest edition, Principles of Organizational Behaviour, Oxford.
- Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. latest edition, Human Resource Management, 5th ed., McGraw Hill.
- Newstrom John W. (2007), Organizational Behaviour, (12th Ed), McGraw Hill.
- Luthan Fred, (2005), Organizational Behaviour, McGraw Hill Inc.
- Robins, Stephen, (2005), Organizational Behaviour, McGraw Hill Inc

Applied Psychology

Course outline:

Understanding Psychology

- Psychology: Scientific perspective
- Historical perspective
- Schools of psychology
- Methods of psychology
- Ethical issues
- Fields of psychology and their application

Biological Basis of Behavior

- Neuron and its function
- Central nervous system
- Peripheral nervous system
- Endocrine system

Sensation and Perception

- Senses: Vision, audition, smell, taste and kinesthetic
- Introduction to perception
- Gestalt principles
- Binocular and monocular cues
- Illusions and extra sensory perception

Learning

- Definition of learning
- Types of learning: Classical and operant conditioning
- Punishment and its effects
- Latent and observational learning

Memory
- Definition and types of memory
- Processes and techniques of improving memory
- Forgetting: Nature and causes

Cognition and Language
- Concept of cognition
- Problem solving
- Judgment and decision making
- Language development
- Language and cognition
- Language and culture

Intelligence and Creativity
- Concept of intelligence
- Theories of intelligence
- Assessment of intelligence
- Mental retardation
- Concept of creativity and its stages

Motivation and Emotion
- Introduction to motivation
- Factors affecting motivation
- Introduction to emotions
- Types of emotions

- Physiology and emotion
- Theories of emotion

Personality
- Defining personality
- Theories of personality
- Personality assessment

Social Thinking and Social Influence
- Social facilitation
- Attribution theory
- Crowd behavior
- Conformity, Obedience
- Helping behavior

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books
- Atkinson R. C., & Smith, E. E. (2000).Introduction to psychology (13th ed.). NY: Harcourt
- Brace College Publishers.
- Coon, D., &Mutterer, J. (2008).Introduction to psychology: Gateways to mind and behavior
- (12th ed.). USA: Wadsworth Cengage Learning.
- Fernald, L. D., & Fernald, P.S (2005).Introduction to psychology. USA; WMC Brown
- Publishers

Engineering Management

Course Outlines
- Industrial networks
- Fundamentals of Product and Process development
- Business Community and New Generations of Managers
- Practical Skills Knowledge and Experience in Commercialization of New Technological Inventions
- Use of Multidisciplinary Science Based Knowledge
- Problem Solving, Teamwork and Outreach Activity,
- Major steps in proof of concept to intellectual property protection,

- Prototype development
- Fabrication and assembly routes
- Materials procurement,
- Identification and creation of new markets
- Development of business plan
- Appropriate technology and marketing
- Distribution and financing
- Routes and strategies for specific technology under development.

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books:
- R. A. Bulgelman, Strategic Management of Technology and innovation, latest Edition McGraw Hill

Marketing Management
Course Outline:

- Defining Marketing For The 21st Century. Importance and scope of Marketing. Discussion on Course outline
- Some fundamental Marketing Concepts, How Marketing Management changed. How does the Marketing affect customer Value? Discussion on Project Outline
- Identifying Market Segments and Targets. Different levels of market segmentation & requirements of effective segmentation? How companies divide a market into segments?
- Creating and delivering Customer Value, satisfaction and loyalty. What is the lifetime value of customers and how can marketers maximize it? How can companies cultivate strong customer relationship? How can companies both attract and retain customers?
- Analyzing Consumer Markets & Globalization How do consumer characteristics influence buying behavior & major psychological processes influence consumer Reponses to the marketing program?
- Crafting the Brand Positioning How can a firm choose and communicate an effective positioning in the market & how brands are differentiated.
- Creating Brand Equity Neuro Marketing How brands create brand Equity
- Setting Product Strategy Product characteristics & classification How companies differentiate products?
- How should a company set prices initially for products or services? When should company initiate a price change? How should a company respond to a competitor's price

change?

- Designing and Managing Value Networks and Channels. The students need to recognize the importance of designing marketing channel system

- Managing Retailing, Wholesaling Why companies choose different marketing channels and how these marketing channels perform?

- Designing & Managing Integrated Marketing Communications Role of Marketing Communication. What are the guidelines for effective marketing communication mix?

- Managing Mass Communications: What steps are required in developing an advertising program? How should sales promotion decisions be made? What are the guidelines for effective brand-building events and experiences?

- Sales Promotions, Events Public Relations. Service Marketing------ Presentation

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books:
- Marketing Management 16th Edition (A South Asian Perspective) by Philip Kotler & Kevin Lane Keller.
- Basic Marketing (1st Edition) by Salman Zaheer
- Blue Ocean Strategy by Renée Mauborgne and W. Chan Kim

Engineering Economics
Course Outline
- **Engineering Economics**

Role of engineers in business; Economic decisions v/s design decisions; Large scale engineering projects and types of strategic economic decisions; Fundamental principles of engineering economics

- **Interest Rate and Economic Equivalence**

Interest: The Cost of Money; Economic Equivalence; Development of Formulas for Equivalence Calculation; Unconventional Equivalence Calculations

- **Understanding Money and Its Management**

Nominal and Effective Interest Rates; Equivalence Calculations with Effective Interest Rates and with Continuous Payments; Changing Interest Rates; Debt Management; Investing in Financial Assets

- **Present-Worth Analysis**

Project Cash Flows; Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis; Variations of Present-Worth Analysis; Comparing Mutually Exclusive Alternatives

- **Annual Equivalent-Worth Analysis**

Annual Equivalent-Worth Criterion; Capital Costs versus Operating Costs; Applying Annual-Worth Analysis; Life-Cycle Cost Analysis; Design Economics

- **Rate-of-Return Analysis**

Rate of Return and Methods of Finding It; Internal Rate-of-Return Criterion; Mutually Exclusive Alternatives

- **Cost Concepts Relevant to Decision Making**

General Cost Terms; Classifying Costs for Financial Statements; Cost Classifications for Predicting Cost Behavior; Future Costs for Business Decisions; Estimating Profit from Production

- **Depreciation and Corporate Taxes**

Asset Depreciation: Economic versus Accounting; Book and Tax Depreciation Methods (MACRS); Depletion ; Income Tax Rate to be used in Economic Analysis; The Need for cash Flow in Engineering Economic Analysis

- **Developing Project Cash Flows**

Cost-Benefit Estimation for Engineering Projects; Developing Cash Flow Statements

- **Project Risk and Uncertainty**

Origins of Project Risk; Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis

- **Special Topics in Engineering Economics**

Replacement Decisions; Capital Budgeting Decisions; Economic Analysis in the Service Sector

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Contemporary Engineering Economics by Chan S. Park, latest edition, Pearson ISBN: 9780134105598
- Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, latest edition, Oxford University Press, ISBN: 978- 0199339273
- Engineering Economy by Leland T. Blank and Anthony Tarquin

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Engineering Project Management

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Course Outline:

- **Project Management Concepts**

History of Project Management, Introduction to Project Management, Project, Program & Portfolio Management, Project characteristics, Objectives& Requirements, Project Phases/Stages, Project Life Cycle, Project Environment, Project Scope & Project Charter, Project Manager, Project Stakeholder Analysis.

- **Project Proposal Development**

Project Proposal, Characteristics of good proposal, Types of Proposals, Request for Proposal, Request for Quotation etc). Proposal Templates etc.

- **Project Feasibility**

Brief review of various aspects of Project Feasibility like Technical, Social, Managerial, Economic, Financial & Marketing, Administrative etc.

- **Project Selection Criteria (Economic Analysis of Engineering Projects)**

Using Break Even Analysis, Cost Benefit Ratio, Internal Rate of Return, Net Present Value etc.

- **Project Contract & Procurement Management**

Engineering contracts, Type of contracts, understanding of procurement Process & Cycle, PPRA Rules

Project Planning and Scheduling

Project Planning (Resource & HR Planning), Work Breakdown Structure, Project Network & Scheduling, Manning Schedule and Activity Charts, Critical Path Method (CPM)/Project Evaluation & Review Techniques

- **Project Costing & Estimation**

Cost Estimation in Projects, Cost components in projects and methods for cost estimation in projects, Cost Control in Projects, Estimation of Outstanding Work, Earned Value Management, Schedule & cost variance analysis

- **Project HRM & Communication Management**

Effective organization and communication for Successful Projects, Project Organizational Structures (Project matrix and project based organizations), Project HR Plan preparation, HR Need Assessment and HR Matrix, Building and Managing effective project team, Selection & control mechanism of HRM in Projects, Effective Communication Plan.

- **Project Risk Management**

Definitions Project Risk, Project Risk Management Tools, Types of Project Risk, Project Risk Assessment, Risk Identification and Mitigation, Monitoring & Controlling Risk, Generic Risk Management Strategies & Technique.

- **Computer Application in Project Management**

Basic/Elementary Introduction and hands on basic exposure of use of MS Project & Primavera P6 Software in Project Management

- **Project Quality Management**

Defining Quality, Quality Assurance, Quality Management, 7 Quality Improvement Tools as applied to Project Management, Project Quality Management Plan, Quality Management Processes and Strategies

- **Project Closure & Termination**

Project Evaluation, defining project success, Project Completion Criteria, Project Audit, Project Termination &When to close a project, the termination process, Project Close Up & lesson learnt, & Project Archive

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books
- Project Management: A system Approach to Planning, Scheduling and Controlling latest Edition, Harold Kerzner
- Bennett, F. Lawrence. Latest edition. The management of engineering. New York: Wiley.
- Cleland, David. Latest edition Field guide to project management. New York: Wiley.
- Eisner, H. Essentials of project management and systems engineering management. New York: Wiley, latest edition.
- Frame, J. D. Managing projects in organizations. San Francisco: Jossey-Bass
- Goldratt, Eliyahu. Latest edition Critical chain. North River Press.
- Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications latest edition.
- Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill, latest edition.
- Lewis, James, P. Latest edition. Mastering project management. New York: McGraw-Hill
- Lientz, Bennet & Rea, Kathryn. Latest edition. Project management for the 21st century. San Diego: Academic Press.
- Miller, Roger & Lessard, Donald. Latest edition. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall, latest edition
- Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall latest edition.
- Project Management by Adrienne Watt, latest edition.
- J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. Latest edition

Entrepreneurship

Course outline
- Develop a business plan with an appropriate business model
- Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial
- career
- Demonstrate the ability to find an attractive market that can be reached economically
Course Outlines
- Basic Concept-Entrepreneurship
- Innovation and Entrepreneurship
- Basic Plan Development Cycle
- Intellectual Rights
- Financial and Legal Modalities

- Marketing
- Industrial Competiveness
- Gap Analysis, Critical Thinking and Idea Generation
- Business Plan Development
- Successful Case Studies (local)

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books
- Michael J Etzel, Bruce J Walker, William J Stanton, Marketing, McGraw-Hill, latest edition
- William D. Bygrave and Andrew Zacharak, Entrepreneurship 2nd Edition, Wiley, latest edition.
- Entrepreneurship by Hisrich, McGraw- Hill, latest edition.
- Principles of Marketing, Cotrell McGraw- Hill, latest edition.
- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship, latest edition.
- P.N. Singh: Entrepreneurship for Economic Growth, latest edition.
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker, latest edition.
- John B. Miner: Entrepreneurial Success, latest edition.
- "Marketing that Works: How Entrepreneurial Marketing Can Add Sustainable Value to Any Sized Company", by Leonard Lodish, Howard Morgan, Shellye Archambeau and Jeffrey Babin, Pearson FT Press, latest edition.
- "Entrepreneurial Marketing," Lessons from Wharton's Pioneering MBA Course, Morgan, H. L., A. Kallianpur, and L. M. Lodish, John Wiley & Sons, latest edition

Financial Management

Course Outline
• Risk and return (Required rate)
Risk and Return Fundamentals: Definition, and Meanings; Basic Model; Risk Preference, Risk Preferences / Behaviors; Risk of a Single Asset: (1) Risk Assessment including Scenario Analysis and Probability Distribution and (2) Risk Measurement including Standard Deviation and Coefficient of Variation; Risk of a Portfolio: Portfolio Return and Standard Deviation, Correlation, Diversification; The Capital Asset Pricing Model (CAPM): (1) Types of risk and (2) The CAPM Model covering Beta Coefficient, The Equation, The Graph, The security Market Line (SML) and Shifts in the security Market Line

- **Short-term Financing Decisions (Current Assets and Current Liabilities)**
- **Current Asset Investment Policies**

- **Working Capital Management**
Working Capital Terminologies: Gross VS Net; Trade-off between Profitability and Risk
- **Cash Operating / Conversion Cycle**
Calculating Cash Conversion Cycle; Funding Requirement of the Cash Conversion Cycle; Cash Management Alternative Strategies; Cash Budget
- **Management of Marketable Securities**
- **Inventory Management**
Inventory Levels and Costs; Common Techniques for managing Inventory
- **Receivables Management**
Credit Selection and Standards; Credit Terms and Policy; Credit Monitoring
- **Management of Receipts and Disbursements**
Float; Speeding-up Receipts and Slowing-down Payments; Cash Concentration; Zero-balance Accounts
- **Generic Current Assets' Management**
Financing Current Assets; Alternative Current Asset Financing Policies; Advantages and disadvantages of Short Term Financing
- **Management of Current Liabilities**
Sources of Short Term Financing; Spontaneous Liabilities; Accounts Payable Management; Accruals; Unsecured Sources of Short Term Financing; Bank Loans; Commercial Papers; Secured Sources of Short Term Financing; Accounts Receivables as Collaterals; Inventory as Collateral
- **Leverage and Capital Structure**
Leverage; Meanings and Use of Leverage; Breakeven Analysis; Operating Leverage; Financing Leverage; Capital Structure; Types/Dimensions of Capital; External Assessment of Capital Structure; Theory of Capital Structure; Target/Optimal Capital Structure, and its Determination; EBIT – EPS Approaches to Capital Structure; Variations in Capital Structures; Comparing Alternative Capital Structures; Capital Structure and Risk; Value Estimation; Maximizing Value VS Maximizing EPS
- **Payout Policy**
Mechanics of Payout Policy; Factors affecting Dividend Policy; Classification of Dividend Policies (General and w.r.t. Pakistan)
- **Long-term Debt Management**
Long-term Debt Considerations; Corporate Bonds; Preferred Stock; Leases; Mergers of Definition of Mergers; Convertible Securities; Options of Major Types of Options

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Recommended Books:
1. Brigham F Eugene, Houston F Joel (Latest edition), Fundamentals of Financial Management, South Western Publishers, Ohio
2. Lawrence J. Gitman, Latest Edition, 'Principles of Managerial Finance'
3. Horne Van, Jr. Wackowicz (Latest Edition), Fundamentals of Financial Management, Apprentice Hall International Inc, New Jersey

Leadership and Personal Grooming

Course outline
- **Fundamentals of Leadership and Servant Leadership**

What is leadership; Leadership Traits; Servant Leadership
- **Foundations of Community Development**

The frame work for community and economic development; Seven theories for seven community developers; Bases of community development; Process of community development; Challenges of the process
- **Social Capital, Community Building and Community Development Practices**

Social capital; Community social capacity and how does it influence development •
Intentional action to increase social capacity; Factors that influence the success of community-building efforts; Principles and process of practicing community development; How does community development practice relate to economic development? Professional standards of ethical practices in community development
- **Community development assessment, Community Asset mapping and surveys, Assessing local economy.**

Community Mapping; Surveys Forms; The importance of asset mapping.
- **Building Powerful Community Organizations**

Bringing a group together; Scanning the functions of Community Organizations present in the market; The idea generation; Developing Vision, Mission and Goals; Structuring the Organization; Defining SOPs
- **Marketing your Organization**

Marketing a Community Organization; Effective role and guidelines for conducting meetings
- **Mobilizing Resources: Raising Money**

Community development finance; Finding sources of money; Securing grants for community development projects; Preparing grant proposals
- **Measuring Progress**

Community development indicators, Best practices & Benchmarking

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Recommended Books:
1. The heart of leadership: A leader people want to follow by Mark Miller, Berret-Kohler Publisher 2013.
2. Leadership and Art of Struggle by Steven Snyder & B. Geage Berret Kohler Publisher 2013.
3. Strategic Leadership: How to think and plan by John Adair, Kogan Page Ltd 2010

Natural Science (Electives)

Course Outline:

Leadership and Personal Grooming

Course outline

- **Fundamentals of Leadership and Servant Leadership**

What is leadership; Leadership Traits; Servant Leadership

- **Foundations of Community Development**

The frame work for community and economic development; Seven theories for seven community developers; Bases of community development; Process of community development; Challenges of the process

- **Social Capital, Community Building and Community Development Practices**

Social capital; Community social capacity and how does it influence development •
Intentional action to increase social capacity; Factors that influence the success of community-building efforts; Principles and process of practicing community development; How does community development practice relate to economic development? Professional standards of ethical practices in community development

- **Community development assessment, Community Asset mapping and surveys, Assessing local economy.**

Community Mapping; Surveys Forms; The importance of asset mapping.

- **Building Powerful Community Organizations**

Bringing a group together; Scanning the functions of Community Organizations present in the market; The idea generation; Developing Vision, Mission and Goals; Structuring the Organization; Defining SOPs

- **Marketing your Organization**

Marketing a Community Organization; Effective role and guidelines for conducting meetings

- **Mobilizing Resources: Raising Money**

Community development finance; Finding sources of money; Securing grants for community development projects; Preparing grant proposals

- **Measuring Progress**

Community development indicators, Best practices & Benchmarking

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Recommended Books:
1. The heart of leadership: A leader people want to follow by Mark Miller, Berret-Kohler Publisher 2013.
2. Leadership and Art of Struggle by Steven Snyder & B. Geage Berret Kohler Publisher 2013.
3. Strategic Leadership: How to think and plan by John Adair, Kogan Page Ltd 2010

Multivariable Calculus

Course Outline:

- **Geometry of Space:**
Analytical Space Geometry, Cylindrical and Spherical coordinates, Lines in space, Intersection of Line and a Plane

- **Vector-Valued Functions and Motion in Space:**
Functions of several variables, their limits and continuity, Quadratic Surfaces, Parametric representation of curves, Velocity and Acceleration, Arc length, Tangent, Normal, Bi-normal, Curvature & Torsion

- **Partial Differentiation:**
Partial derivatives, Total Differentials, Chain Rule with More Variables, Directional derivatives

- **Applications of Partial Derivatives:**
Optimization Problems, Extrema of functions of several variables, Conditional extrema, Lagrange Multipliers and Example

- **Multiple Integrals:**
Double Integration, Order of Integration, Double Integrals in Polar Coordinates, Applications: Mass and Average Value, Moment of Inertia, Triple Integrals, Rectangular and Cylindrical Coordinates, Applications and Examples, Triple Integrals in Spherical Coordinates

- **Vectors in 3 Space:**
Introduction to vectors, Scalar and vector product, Volume of parallelepiped and tetrahedron, Gradient of a Scalar Field, Divergence of a Vector Field, Curl of a Vector Field

- **Integration in Vector Fields:**
Line Integral, Integration Around Closed Curves. Work Done, Potential and Related Examples, Conservative and non-Conservative Fields, Green's Theorem, Divergence Theorem, Stoke's Theorem, Applications of Double and Triple integrals

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass. Pearson, USA.
- George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry
- Swokowski, Onlinick & Pence: Calculus
- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendental by James Stewart, Brooks/Cole USA

Discrete Mathematics

Course outline

- Number Theory. Introduction to Sets. Set operations and properties. Venn diagrams.
- Sequences and Strings.
- Relations.
- Functions.
- Propositional logic. Conditional propositions and logical equivalence.
- Proofs. Rules of inference. Mathematical induction and recursion.
- Matrices.
- Revision
- Boolean Algebra
- Algorithms, integers and recursion.
- Counting Techniques
- Introducing graphs and trees.
- Algebraic structures.
- Languages and Grammars.
- Finite state machines.
- Revision

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Text Books:
1. Kenneth H.Rosen, "Discrete Mathematics and Its Applications", 7th Edition, McGraw Hill Books Co., 2012
2. Richard Johnsonbaugh, "Discrete Mathematics", 8th Edition, Pearson Education Asia, 2018.

Numerical Analysis

Course Outline

• Error Analysis and Interpolation

Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision
Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, Relevant engineering case studies

• Numerical Differentiation and Integration

Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five points formulas along with its application in engineering, Relevant case studies
Numerical integration: Trapezoidal rule, Simpson's rules, Composite Trapezoidal Simpson Rules and Romberg integration, Applications of numerical in engineering, Relevant case studies

• Methods of solution a system of Linear Equations
Solution of system of linear algebraic equations, Gauss elimination method
LU factorization, Tridiagonal solver
Applications of these methods in engineering disciplines, Relevant case studies

• Iterative Methods for Linear and Nonlinear Equations

Numerical Solution of nonlinear equations: Bisection method, Newton's method, Secant method, Convergence analysis of these methods
Newton's method for system of nonlinear equations
Solution of system of linear equations by Jacobi, Gauss Seidel and SOR methods, Applications of these methods in engineering disciplines, Relevant case studies

• Numerical Methods for IVPs and BVPs
Euler's method and its variations, Taylor's higher order methods, Error analysis, Consistency, stability and convergence
Runge-Kutta methods of order 2, 3, and 4, Stiff ODEs, Consistency, stability and convergence
Linear multistep methods, Numerical solution of system of ODEs
Numerical solution of BVPs by Finite Difference Method
Applications in engineering: Some relevant case studies

• Numerical Methods for Computing Eigenvalues

Eigenvalues and Eigenvectors of matrix: power method; Inverse power method, Shifted inverse power method; Applications of eigenvalues in engineering disciplines.

• Numerical Optimization

Unconstrained Optimization, Golden search ratio, Lagrange Multipliers, Method of steepest descent; Applications of optimization in engineering disciplines

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Numerical Analysis: By Richard L. Burden, J. Douglas Faires, Latest Edition
- Numerical methods for scientist and engineers by R.W. Hamming (Latest Edition)
- Numerical methods for Engineers by Steven C. Chapra and R. P. Canale (Latest Edition)

Applied Chemistry

Course outline

● Basic of Elemental Chemistry, Electrochemistry, Conductive metals, Conductance and Resistance of various metals, Electrode Fabrication, Electrolytic Cells, Galvanic Cells, Cell potentials, Modification of Batteries, Transistors, resistors, capacitors and inductors modification, Corrosions, Surface Chemistry.

● Fabrication of computer chips, Solder: New requirements for lead-free fabrication to a leadfree solder. Liquid Cooling. Various coolants and their level of cooling

● Introduction and laws of Thermodynamics & heat transfer, Heat of Reactions, Entropy, Heat of Combustion & Formation, Endothermic and Exothermic Reactions & Factors involved, Fluid Chemistry, Fluids types and its Properties, Fluids and Electrolytes.

● Mechanics of Materials: Nature properties and Electrical composition of materials, ceramics, metals, Characterization of materials by using Spectroscopic Techniques, Tribology

Teaching Methodology (Proposed as applicable):
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

Suggested Books

- "Fundamentals of Thermal Fluid Sciences" Yunus A. Cengel and Co-authors McGrawHill Education; latest edition.
- "Essentials of Polymer Science and Engineering" Paul C Painter and Co-authors, DEStech Publications, latest edition.
- Power Electronics Handbook, 4th Ed. by Muhammad H Rashid, Elsevier Inc. latest edition.
- Advances in Heat Transfer, Edited by Ephraim M. Sparrow, John P. Abraham, John
- M. Gorman, W. J. Minkowycz, Volume 51 Elsevier Ltd, latest edition

- Handbook of Green Information and Communication Systems, Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, Elsevier Inc, latest edition
- .• Interstellar Molecules, Their Laboratory and Interstellar Habitat, Editors: Yamada, Koichi M. T., Winnewisser, Gisbert (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.
- Recent Advances in Spectroscopy, Theoretical, Astrophysical and Experimental, latest edition.
- Perspectives, Editors: Chaudhuri, R.K., Mekkaden, M.V., Raveendran, A.V., Narayanan, A.S. (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.
- Nanoscale, Authors: Oscar Alejandro Oviedo, Luis Reinaudi, Silvana Graciela
- García, Ezequiel Pedro Marcos Leiva, Editor: Fritz Scholz, Publisher: Springer, latest edition
- ElectroElectrical Energy Systems - Foundations, Energy Storage and Conversion, Artur Braun, Publisher: De Gruyter, latest edition"
- An Introduction to Electrochemistry, By S. Glasstone, Publisher Maurice Press, latest edition.
- "Advanced Heat and Mass Transfer" Amir Faghri, Yuwen Zhang, John Howell, Global Digital Press, latest edition