DATA COMMUNICATION
ENCT 253

Lecture : 3 **Year :II**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The objective of this course is to provide students with a solid foundation in the principles and theories of data communication, including key terminology, protocols, and standards. Also support to explore the various types of transmission media, including guided and unguided media, and their characteristics, advantages, and disadvantages. Furthermore, it introduces the methods of data encoding, modulation techniques, and their implications for effective data transmission.

1 Introduction (4 hours)

1.1 Analog data communication, data representation, data flows
1.2 Evolution of data communication
1.3 A communication model, data communication model
1.4 Networks (LAN, WAN), simplified network architecture, the OSI model
1.5 Data communication and networking for today enterprise

2 Data Communication Fundamentals (6 hours)

2.1 Analog and digital data
2.2 Analog signals, periodic and aperiodic signals, periodic signals characteristics (Time, frequency domain)
2.3 Introduction to Fourier series representation of periodic signal, Fourier transform representation of aperiodic signals, digital signals and its characteristics
2.4 Analog and digital transmission, transmission mode, transmission impairments (Attenuation, distortion, noise)
2.5 Data rate limits channel capacity, Nyquist bandwidth, Shannon capacity formula
2.6 Performance of network (Bandwidth, throughput, latency, jitter)

3 Transmission Media and Data Compression (8 hours)

3.1 Guided transmission media: Co-axial cable, twisted pair, optical fiber
3.2 Unguided transmission media: Radio waves, microwaves, infrared
3.3 Antenna basics, satellite communication, Bluetooth, Wi-Fi

3.4 Wireless propagation (Introduction to groundwave propagation, sky wave propagation and line of sight propagation), frequency bands
3.5 Error detection and correction: Parity, check sum, cyclic redundancy check, hamming code
3.6 Data compression: Lossy and lossless

4 Signal Encoding Technique (15 hours)

4.1 Analog data, analog signals: Modulation and its need, AM, FM, PM
4.2 Analog data, digital signals: PAM, PWM, PPM, PCM, DPCM, DM
4.3 Digital data, analog signal: ASK, FSK, PSK, QPSK, QAM
4.4 Digital data, digital signal: RZ, NRZ, AMI, Manchester, differential Manchester, B8ZS, HDB3 for data transmission

5 Multiplexing and Switching (8 hours)

5.1 Access introduction to multiplexing, application of multiplexing
5.2 Frequency division multiple
5.3 Time division multiple access
5.4 Asymmetric digital subscriber line, XDSL
5.5 Spread spectrum: DHSS, FHSS, CDMA
5.6 Intro switched communication network, connection oriented and connectionless
5.7 Switching devices: Types, importance and application
5.8 Circuit switching network: Circuit switching concepts, message switching
5.9 Packet switching: Virtual switching, datagram switching

6 Cellular Wireless Communications and Latest Trends (4 hours)

6.1 Overview of 1G, 2G, 3G and 4G
6.2 Cellular technology fundamental terminology: Cell, frequency-reuse, cluster, adjacent cell interference, co-channel interference, handoff strategies, architecture of GSM basics
6.3 Introduction to 5G networks, software defined networking, IOT communication, cloud computing and virtualization in data communication

Tutorial (15 hours)

1. Tutorials on different protocols in data communication TCP/IP, HTTP/HTTPS, FTP
2. Explore the function of open systems interconnection (OSI) model, which defines seven layers of data communication
3. Discover data communication devices and its application
4. Identify the application of used network topologies in present scenario
5. Collecting ideas on some security aspects of the security on data communication on present enterprises system

Practical **(22.5 hours)**

1. Signal analysis using MATLAB
2. Implementation of small network using hub and switch in physical or simulation environment
3. Analog modulation generation and reconstruction
4. Pulse modulation generation and reconstruction
5. Conversion of given binary sequence into different line coding
6. Digital modulation (ASK, FSK, PSK) generation and reconstruction

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	4	5
2	6	9
3	8	11
4	15	20
5	8	10
6	4	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Stallings, W. (2007). Data and Computer Communications. India: Pearson Education.
2. Forouzan, B. A., Fegan, S. C. (2007). Data Communications and Networking (McGraw-Hill Forouzan Networking). United Kingdom: McGraw-Hill Higher Education.
3. Tanenbaum, A. S., Wetherall, D. (2011). Computer Networks. India: Pearson Prentice Hall.
4. Rappaport, T. S. (2024). Wireless Communications: Principles and Practice. United Kingdom: Cambridge University Press.

DATA STRUCTURE AND ALGORITHMS
ENCT 252

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 3

Course Objectives:
The objective of this course is to impart fundamental knowledge on the design and implementation of data structures for storing information. It also covers various algorithms used in computer science. Upon completion of this course, students will be able to design and choose the appropriate data structure and efficient algorithm to achieve optimal performance

1 Introduction (4 hours)

1.1 Introduction to data structures
  1.1.1 Need of data structures
  1.1.2 Types of data structures and its characteristics
1.2 Abstract data type (ADT)
1.3 Basics of algorithm design techniques (Brute Force, divide and conquer, Greedy algorithms, branch and bound, backtracking, randomized, recursive, dynamic programming)
1.4 Algorithm analysis
  1.4.1 Time and space complexity
  1.4.2 Best, worst and average case analysis
  1.4.3 Rate of growth
  1.4.4 Asymptotic notations: Big Oh, Big Omega and Big Theta

2 Stack and Recursion (7 hours)

2.1 Definition of stack and its operations
2.2 Array implementation of stack ADT
2.3 Stack applications
  2.3.1 Expression conversion: Infix to postfix and prefix expression
  2.3.2 Expression evaluation: Infix and postfix expression evaluation
2.4 Recursion
  2.4.1 Concept of recursion
  2.4.2 Recursion and stack
  2.4.3 Recursion vs iteration
  2.4.4 Execution of recursive calls
  2.4.5 Types of recursions
  2.4.6 Applications of recursion: Tower of Hanoi

3 Queues (5 hours)

- 3.1 Definition of queue and its operations
- 3.2 Array implementation of queue ADT
- 3.3 Types of queue ADT: Linear, circular, double ended and priority queues

4 Linked List (6 hours)

- 4.1 Definition of list and its operations
- 4.2 Array implementation of list ADT
- 4.3 Static list and its limitations
- 4.4 Linked list: Definition and its operations
- 4.5 Types of linked list: Singly, doubly, circular
- 4.6 Application of linked list
  - 4.6.1 Linked list implementation of stack and queue ADT
  - 4.6.2 Solving polynomial equations using linked list

5 Tree (7 hours)

- 5.1 Definition and tree terminologies
- 5.2 Binary trees
  - 5.2.1 Definition and types
  - 5.2.2 Array and linked list representation
  - 5.2.3 Traversal algorithms: Pre-order, in-order and post-order traversal
  - 5.2.4 Application of full binary tree: Huffman algorithm
- 5.3 Binary search tree
  - 5.3.1 Definition and operations on binary search tree: Insertion, deletion, searching and traversing
  - 5.3.2 Construction of binary search tree
- 5.4 Balanced binary tree
  - 5.4.1 Problem with unbalanced binary trees
  - 5.4.2 Balanced binary search tree
  - 5.4.3 AVL tree, definition and need of AVL tree, construction of AVL tree: Insertion, deletion on AVL tree and rotation operations
- 5.5 Introduction to red-black tree
- 5.6 B-Tree: Need, definition and construction of B-tree

6 Graphs (6 hours)

- 6.1 Definition, terminologies and types of graphs
- 6.2 Representation of graphs: Adjacency matrix, incidence matrix and adjacency list
- 6.3 Transitive closure and Warshall's algorithm
- 6.4 Graph traversals: Breadth-first search, depth-first search and topological sort

6.5 Minimum spanning tree: Kruskal's algorithm and prim's algorithm
6.6 Shortest-paths problems: Dijkstra's algorithm, Floyd- Warshall algorithm

7 Sorting Algorithms (5 hours)

7.1 Definition of sorting and its applications
7.2 Types of sorting: Internal/external sort, stable/unstable sort, in-place/ not in-place sort, adaptive/ non-adaptive sort
7.3 Sorting algorithms and its efficiency: Bubble, insertion, selection, shell, quick, merge, radix and heap sorting

8 Searching Algorithms (5 hours)

8.1 Definition of searching techniques and its applications
8.2 Different searching algorithms and its efficiency
    8.2.1 Sequential search
    8.2.2 Binary search
8.3 Hashing
    8.3.1 Definition and its applications
    8.3.2 Hash function
    8.3.3 Hash table
    8.3.4 Collision in hash table
    8.3.5 Collision resolution techniques: Chaining method and open addressing method (Linear probing, quadratic probing and double hashing)

Tutorial (15 hours)

1. Analyzing time and space complexity of basic algorithms and comparing best, worst, and average cases with examples
2. Solving problems using stacks: Converting infix expressions to postfix/prefix, evaluating postfix expressions, balancing parentheses, reversing a string
3. Solving Tower of Hanoi recursively and analyzing tail vs non-tail recursion
4. Solving polynomial addition using linked lists
5. Implementing tree traversals: Preorder, inorder, postorder
6. Constructing a binary search tree (BST) and performing insertion, deletion, and searching, balancing BSTs with AVL tree operations (Rotations, insertion, deletion), constructing B-Trees (Insertion, deletion)
7. Implementing Huffman coding for text compression
8. Solving shortest path problems using Dijkstra's and Floyd-Warshall algorithms
9. Implementing Kruskal's and Prim's algorithms for minimum spanning tree
10. Analyzing and comparing sorting algorithm efficiencies
11. Implementing linear search and binary search
12. Designing a hash table with different collision resolution techniques (Chaining, linear probing, quadratic probing, double hashing)

Practical **(45 hours)**

1. Implementation of stack using array, applications of stack- conversion of infix to prefix and postfix expression, evaluation of prefix and postfix expression, matching parenthesis, reversal of string
2. Implementation of recursive algorithms (Tail and non-tail method)- Factorial, sum of natural numbers, Fibonacci series, implementation of Tower of Hanoi
3. Implementations of linear queue and circular queue using arrays
4. Implementation of static list, implementation of linked list: Singly and doubly linked lists
5. Implementation of stack and queue using linked list, application of linked list- polynomial addition
6. Implementation of in-order, pre-order and post-order tree traversals
7. Implementation of breadth-first and depth-first search to traverse a graph
8. Implementation of different sorting algorithms
9. Implementation of different searching algorithms

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	5
2	7	9
3	5	7
4	6	8
5	7	9
6	6	8
7	5	7
8	5	7
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Langsam, Y. Augenstein .M. J. and Tenenbaum A. M. (1996). Data Structures using C and C++. Prentice Hall Press.
2. Rowe, G. W. (1997). Introduction to data structures and algorithms with C++. Prentice-Hall, India.
3. Cormen, T. H., Leiserson, C. E., Rivest, R. L., and Stein, C, (2022). Introduction to algorithms. MIT press.
4. Kruse, R. L., and Ryba, A. J., (1998). Data structures and program design in C++. Prentice Hall, India.
5. Thareja, R. (2014). Data Structures Using C. Oxford University Press.

ELECTROMAGNETICS
ENEX 254

Lecture : 3 | **Year :II**
Tutorial : 1 | **Part : II**
Practical : 3/2

Course Objectives:
The objective of this course is to provide students with a basic mathematical concepts related to electromagnetic time invariant and time variant fields including electromagnetic wave and their transmission on different media

1 Introduction (4 hours)

1.1 Scalar and vector fields
1.2 Operations on scalar and vector fields
1.3 Co-ordinate systems (Cartesian, cylindrical and spherical) and conversions

2 Electric Field (15 hours)

2.1 Coulomb's law
2.2 Electric field intensity
2.3 Electric flux density
2.4 Gauss's law and applications
2.5 Physical significance of divergence, divergence theorem
2.6 Electric potential, potential gradient
2.7 Energy density in electrostatic field
2.8 Electric properties of material medium
2.9 Free and bound charges, polarization, relative permittivity, electric dipole electric boundary conditions
2.10 Current, current density, conservation of charge, continuity equation, relaxation time
2.11 Boundary value problems, Laplace and Poisson equations and their solutions, uniqueness theorem

3 Magnetic Field (9 hours)

3.1 Biot-Savart's law
3.2 Magnetic field intensity
3.3 Ampere's circuital law and its application
3.4 Magnetic flux density
3.5 Physical significance of curl, Stoke's theorem
3.6 Scalar and magnetic vector potential
3.7 Magnetic properties of material medium

3.8 Magnetic force, magnetic torque, magnetic moment, magnetic dipole, magnetization
3.9 Magnetic boundary condition

4 Time Varying Fields (4 hours)

4.1 Faraday's law, transformer EMF, motional EMF
4.2 Displacement current
4.3 Maxwell's equations in integral and point forms

5 Plane Waves (9 hours)

5.1 Wave propagation in lossless and lossy dielectric
5.2 Plane waves in free space, lossless dielectric, good conductor
5.3 Power and poynting theorem average power density
5.4 Reflection of plane wave at normal incidence
5.5 Standing wave and SWR
5.6 Input intrinsic impedance

6 Transmission Lines (4 hours)

6.1 Transmission line equations (Taking analogy from wave equations)
6.2 Lossless, lossy and distortionless transmission lines
6.3 Input impedance, reflection coefficient, standing wave ratio

Tutorial (15 hours)

1. Conversion of coordinate systems (Cartesian to cylindrical /spherical and vice versa, cylindrical to spherical and vice versa)
2. Electric field intensity and flux density (Coulomb's law, Gauss law, divergence, electric potential and energy density)
3. Boundary condition, electric dipole, and boundary value problems
4. Magnetic fields (Biot-Savart law, Ampere circuit law, Stoke's theorem, magnetic force and torque)
5. Time varying fields (Transformer/motional EMF, displacement current)
6. Wave propagation equations in lossy and lossless medium (Poynting theorem, standing wave ratio and intrinsic impedance)
7. Transmission line (Lossless, lossy and distortionless)

Practical (22.5 hours)

1. Teledeltos (Electro-conductive) paper mapping of electrostatic fields
2. Determination of dielectric constant, display of a magnetic hysteresis loop
3. Studies of wave propagation on a lumped parameter transmission line
4. Microwave sources, detectors, transmission lines
5. Standing wave patterns on transmission lines, reflections, power patterns on transmission lines, reflections, power measurement
6. Familiarizations of electric and magnetic field measurements using simulation tool

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	5
2	15	20
3	9	12
4	4	6
5	9	12
6	4	5
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Hayt, W. H. (2001). Engineering Electromagnetics. McGraw-Hill Book Company.
2. Kraus, J. D. (1973). Electromagnetics. McGraw-Hill Book Company.
3. Rao, N. N. (1990). Elements of Engineering Electromagnetics. Prentice Hall.
4. Devid K. Cheng, (1989). Field and Wave Electromagnetics. Addison-Wesley.
5. Sadiku, M. N. O. (2010). Elements of Electromagnetics. Oxford University Press.

INSTRUMENTATION
ENEX 252

Lecture : 4 **Year : II**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The objective of this course is to provide comprehensive understanding on methods and instrument for a wide range of measurement problems used in instrumentation system. It also covers application of transducers in the microprocessor, microcontroller and their interfacing to design instrumentation system.

1 Introduction (2 hours)

1.1 Analog and digital instrument: Definition, block diagram, characteristics
1.2 Microprocessor-based systems: Open vs closed loop, benefits, features and applications in instrumentation design
1.3 Microcomputer on instrumentation design

2 Theory of Measurement (6 hours)

2.1 Static performance parameters: Accuracy, precision, sensitivity, resolution and linearity
2.2 Dynamic performance parameters: Response time, frequency response and bandwidth
2.3 Error in measurement
2.4 Statistical analysis of error in measurement
2.5 Measurement of resistance (Low, medium and high)
2.6 DC / AC bridge (Wheatstone bridge, Maxwell's bridge, Schering bridge)

3 Transducer (8 hours)

3.1 Transducer, workflow of a transducer in typical system, transducer classification
3.2 Sensor and its working principle (Resistive, capacitive and piezoelectric), generation of sensor, classification of sensor (Analog sensor, digital sensor)
3.3 Types of sensors (Electrical sensor, chemical sensor, biological sensor, acoustic sensor, optical sensor and other motion sensor), characteristic of sensors
3.4 Actuator, classification of actuators (Hydraulic, pneumatic, electric and mechanical), characteristic of actuator

4 Interfacing of Instrumentation System (14 hours)

- 4.1 Microprocessor and microcontroller and their selection criteria, and applications
- 4.2 The PPI 8255 and interfacing of peripherals (LED, 7 segment, dip switch, 8-bit ADC, 8/10-bit DAC using mode 0 and mode1) with 8085 microprocessor
- 4.3 Microcontrollers (Atmega328, STM32): Architecture, pin configuration, and their application
- 4.4 Sensor/Actuator interfacing with Atmega328P (Arduino): Analog and digital sensors, implementation of communication protocols, interrupt based interfacing

5 Connectivity Technology in Instrumentation System (6 hours)

- 5.1 Wired and wireless communication system
- 5.2 Wired connectivity: UART, I2C, SPI, CAN
- 5.3 Wireless sensor network and its technology
- 5.4 RF modem, Bluetooth, WI-FI, NFC, ZIGBEE and LORA
- 5.5 Thermal management: Heat dissipation technique, heat sink
- 5.6 Data acquisition system (Data loggers, data archiving and storage), cloud based data acquisition system

6 Circuit Design (4 hours)

- 6.1 Converting requirement into design, reliability and fault tolerance
- 6.2 High-speed design: Bandwidth, decoupling, crosstalk, impedance matching
- 6.3 PCB design: Component placement, trace routing, signal integrity, and ground loops
- 6.4 Noise and noise coupling mechanism, noise prevention, filtering, ferrite beads, decoupling capacitors, and ESD & its prevention

7 Software for Instrumentation Application (6 hours)

- 7.1 Overview of software engineering
- 7.2 Types of software
- 7.3 Software development life cycle (SDLC), software process models (Waterfall model, prototype model, incremental model, agile model)
- 7.4 Software reliability vs hardware reliability
- 7.5 Software bugs, software testing, different levels of testing

8 Electrical Equipment (6 hours)

- 8.1 Voltmeter and ammeter: Types and working principle
- 8.2 Energy meter: Types and working principle
- 8.3 Frequency meter: Types and working principle
- 8.4 Wattmeter: Types and working principle

9 Latest Trends (3 hours)

- 9.1 Internet of things (IoT): Simple architecture, characteristics, advantages
- 9.2 Smart sensors
- 9.3 Important of cloud computing in instrumentation system
- 9.4 Instrumentation in industry 4.0/5.0

10 Application of Modern Instrumentation System (5 hours)

- 10.1 Instrumentation for power station including all electrical and non-electrical parameters
- 10.2 Instrumentation for wire and cable manufacturing and bottling plant
- 10.3 Instrumentations for a beverage manufacturing and bottling plant
- 10.4 Instrumentations required for a biomedical application such as a medical clinic or hospital
- 10.5 Instrumentation system design using a processor (Microprocessor, microcontroller or others)

Tutorial (15 hours)

1. Understanding the fundamentals of Op-amps is essential since they are central to analog instrumentation.
2. Learn how to filter, amplify, and modify analog signals for signal conditioning
3. How ADCs and DACs work and how to select the right one for your application
4. Interfacing of ADC on any application of your interest
5. Application for the protocol UART, I2C, SPI in Adriano
6. Design a simple temperature sensing system using a thermistor or thermocouple, op-amp, and analog display.
7. Explain the generation of PWM signals in ATmega328P for controlling things like motor speed or LED brightness.

Practical (22.5 hours)

1. Measurement and accuracy testing: Analog and digital meters
2. Use of LabVIEW, Proteus, MATLAB or others for modeling instrumentation systems
3. Use of resistive, capacitive & inductive transducers / sensors / actuators
4. Review of assembly programming and simple I/O interfacing with 8085 and 8255
5. Interfacing of LEDs, seven segment display and motors
6. Interfacing of ADC and DAC

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	4
2	6	5
3	8	6
4	14	12
5	6	6
6	4	4
7	6	6
8	6	6
9	3	5
10	5	6
Total	**60**	**60**

* There may be minor deviation in marks distribution.

References

1. Hall, D. V., (1999). Microprocessor and Interfacing, Programming and Hardware. Tata McGraw Hill
2. Goankar, R. S., (2000). Microprocessor Architecture, Programming and Application with 8085. Prentice Hall
3. Fowler, K. R., (1996). Electronic Instrument Design: Architecting for the Life Cycle. Oxford University Press, Inc.
4. Sawhney, A. K., (1998). A Course in Electronic Measurement and Instrumentation. Dhanpat Rai and Sons.
5. Gupta, J. B., (2008). A Course in Electrical and Electronics Measurement and Instrumentation, Kataria and Sons.
6. DE Silva C. W., Sensors and Actuators: Control System Instrumentation. CRC Press Taylor and French Group Boca Raton London New York.
7. Misra, S., Roy, C. and Mukherjee, A., (2020). Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.

NUMERICAL METHODS
ENSH 252

Lecture : 3 | **Year : II**
Tutorial : 1 | **Part : II**
Practical : 3

Course Objectives:
The objective of this course is to equip students with a thorough understanding of numerical methods, focusing on their application in obtaining approximate solutions to complex mathematical problems commonly encountered in science and engineering. Emphasizing algorithm development, programming, and visualization techniques, the course enables students to apply computational approaches effectively, enhancing their problem-solving capabilities in real-world applications.

1 Solution of Non-Linear Equations (7 hours)

1.1 Errors and accuracy in numerical computations
1.2 Bisection method
1.3 Regula Falsi method and secant method
1.4 Newton Raphson method
1.5 Fixed point iteration method
1.6 Comparison of the methods (Bracketing vs open-ended methods and rates of convergence)
1.7 Solution of system of non-linear equations
  1.7.1 Direct approach
  1.7.2 Newton Raphson method

2 Solution of System of Linear Algebraic Equations (8 hours)

2.1 Direct methods
  2.1.1 Gauss Jordan method
  2.1.2 Gauss elimination method, pivoting strategies (Partial and complete)
  2.1.3 Matrix inverse using Gauss Jordan and Gauss elimination methods
  2.1.4 Factorization methods (Do-Little’s method and Crout’s method)
2.2 Iterative methods
  2.2.1 Jacobi’s method
  2.2.2 Gauss-Seidal method
2.3 Determination of largest and smallest Eigen values and corresponding vectors using the power method

3 Interpolation (9 hours)

- 3.1 Polynomial Interpolation
  - 3.1.1 Finite differences (Forward, backward, central and divided differences)
  - 3.1.2 Interpolation with equally spaced intervals: Newton's forward and backward difference interpolation, Stirling's and Bessel's central difference interpolation
  - 3.1.3 Interpolation with unequally spaced intervals: Newton's divided difference interpolation, Lagrange interpolation
- 3.2 Least square method of curve fitting
  - 3.2.1 Linear form and forms reducible to linear form
  - 3.2.2 Quadratic form and forms reducible to quadratic form
  - 3.2.3 Higher degree polynomials
- 3.3 Cubic spline interpolation
  - 3.3.1 Equally spaced interval
  - 3.3.2 Unequally spaced interval

4 Numerical Differentiation and Integration (6 hours)

- 4.1 Numerical differentiation
  - 4.1.1 Differentiation using polynomial interpolation formulae for equally spaced intervals
  - 4.1.2 Local maxima and minima from equally spaced data
- 4.2 Numerical integration
  - 4.2.1 Newton Cote's general quadrature formula
  - 4.2.2 Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Boole's rule, Weddle's rule
  - 4.2.3 Romberg integration
  - 4.2.4 Gauss-Legendre integration (up to 3-point formula)

5 Solution of Ordinary Differential Equations (ODE) (8 hours)

- 5.1 Initial value problems
  - 5.1.1 Solution of first order equations: Taylor's series method, Euler's method, Runge-Kutta methods (Second and fourth order)
  - 5.1.2 Solution of system of first order ODEs via Runge-Kutta methods
  - 5.1.3 Solution of second order ODEs via Runge-Kutta methods
- 5.2 Two-point boundary value problems
  - 5.2.1 Shooting method
  - 5.2.2 Finite difference method

6 Solution of Partial Differential Equations (7 hours)

- 6.1 Introduction and classification
- 6.2 Finite difference approximations of partial derivatives
- 6.3 Solution of elliptic equations
  - 6.3.1 Laplace equation
  - 6.3.2 Poisson's equation
- 6.4 Solution of parabolic and hyperbolic equations
  - 6.4.1 One-dimensional heat equation: Bendre-Schmidt method, Crank-Nicolson method
  - 6.4.2 Solution of wave equation

Tutorial (15 hours)

1. Solution of non-linear equations
2. Solution of system of linear algebraic equations
3. Polynomial interpolation
4. Least square method of curve fitting
5. Cubic spline interpolation
6. Numerical differentiation
7. Numerical Integration
8. Solution of ordinary differential equations (Initial value problems)
9. Solution of ordinary differential equations (Boundary value problems)
10. Solution of partial differential equations

Practical (45 hours)

Programming language to be used: Python
Results to be visualized graphically wherever possible
Practical report contents: Working principle, Pseudocode, Source code, Test Cases

1. Basics of programming in Python:
   - Basic input/output
   - Basic data types and data structures
   - Control flow
   - Functions and modules
   - Basic numerical and scientific computation
   - Graphical visualization
2. Solution of Non-linear equations:
   - Bisection method
   - Secant method
   - Newton-Raphson
   - System of non-linear equations using Newton-Raphson method
3. System of linear algebraic equations:
   - Gauss Jordan Method
   - Gauss elimination method with partial pivoting
   - Gauss-Seidal method
   - Power method

4. Interpolation
    Newton's forward difference interpolation
    Lagrange interpolation
    Least square method for linear, exponential and polynomial curve fitting
    Cubic spline interpolation
5. Numerical Integration
    Trapezoidal rule
    Simpson's 1/3 rule or Simpson's 3/8 rule
    Boole's Rule or Weddle's Rule
    Gauss-Legendre integration
6. Solution of Ordinary Differential Equations:
    Runge-Kutta fourth order method for first order ODE
    Runge-Kutta fourth order method for system of ODEs / 2^{nd} order ODE
    Solution of two-point boundary value problem using Shooting method
    Solution of two-point boundary value problem using finite difference method
7. Solution of partial differential equations using finite difference approach:
    Laplace equation using Gauss-Seidal iteration
    Poisson's equation using Gauss-Seidal iteration
    One-dimensional heat equation using Bendre-Schmidt method
    One-dimensional heat equation using Crank-Nicholson method

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	7	10
2	8	10
3	9	10
4	6	10
5	8	10
6	7	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Chapra, S. C., Canale, R. P. (2010). Numerical Methods for Engineers (6th edition). McGraw-Hill.
2. Kiusalaas, J. (2013). Numerical Methods in Engineering with Python 3 (3rd edition). Cambridge University Press.
3. Grewal, B. S. (2017). Numerical Methods in Engineering & Science (11th edition). India: Khanna Publishers.
4. Yakowitz, S., Szidarovszky, F. (1986). An Introduction to Numerical Computations (2nd edition). Macmillan Publishing.
5. Kong, Q., Siauw T., Bayen A. (2020). Python Programming and Numerical Methods. Academic Press.

OPERATING SYSTEM

ENCT 254

Lecture : 3 | **Year : II**
Tutorial : 1 | **Part : II**
Practical : 3/2

Course Objectives:

The objective of this course is to familiarize students with the different aspects of operating systems and encourage them to use these ideas in designing operating systems.

1 Introduction (6 hours)

1.1 Introduction to operating systems
1.2 OS as an extended machine and resource manager
1.3 History of operating system
1.4 Type of operating system: Mainframe, server, personal, smartphone and handheld, IOT and embedded, real-time, smart-card
1.5 Operating system components: Kernel, shell, utilities, applications
1.6 Types of OS kernel: Monolithic, micro, nano, layered, hybrid, exo-kernel
1.7 System calls, shell commands, shell programming
1.8 POSIX standard
1.9 Bootloader, MBR/GPT, UEFI and legacy boot

2 Process Management (7 hours)

2.1 Process description, states and control
2.2 Scheduling algorithms
  2.2.1 First Come First Serve (FCFS)
  2.2.2 Shortest Job First (SJF)
  2.2.3 Shortest Remaining Time(SRT)
  2.2.4 Round Robin (RR)
  2.2.5 Highest Response Ratio Next (HRNN)
  2.2.6 Completely Fair Scheduler (CFS) used in Linux
2.3 Threads and thread scheduling

3 Process Communication and Synchronization (10 hours)

3.1 Principles of concurrency, race condition, critical region
3.2 Mutual exclusion, semaphores, and mutex
3.3 Message passing and monitors
3.4 Classical problems of synchronization: Readers-writers problem, producer-consumer problem, dining philosopher problem
3.5 Deadlock: Prevention, ignorance, avoidance, detection and recovery

4 I/O and Memory Management (9 hours)

4.1 I/O management

4.1.1 Principles of I/O hardware and software

4.1.2 I/O software layer

4.1.3 Disk technologies: Magnetic disk, SSD, NVMe storage

4.1.4 RAID

4.1.5 Concept of stable storage, cost per bit comparison

4.2 Memory Management

4.2.1 Memory address, swapping and managing free memory space

4.2.2 Virtual memory management, paging, segmentation

4.2.3 Page replacement algorithms (FIFO, LRU, LFU), page fault and hit ratio

4.2.4 Allocation of frames

4.2.5 Thrashing

5 File Systems (3 hours)

5.1 File concepts: Name, structure, types, access, attributes, operations

5.2 Directory structures: Paths and hierarchies (Linux/Windows)

5.3 File system implementation: Inodes, allocation methods (Contiguous, linked, indexed)

5.4 File system performance: Factors affecting efficiency

5.5 Example file systems: NTFS, EXT4, FAT32, NFS

6 Security and System Administration (3 hours)

6.1 OS security: Cryptography, multi-factor authentication (MFA), secure boot and sandboxing

6.2 Access control: Policies, lists, and OS support

6.3 System administration: User management, environment setup and tools (AWK, shell scripts, make)

7 Hypervisors and Virtual Systems (4 hours)

7.1 Hypervisors: Type 1 and type 2

7.2 Virtual machines: Creating virtual machine in Qemu/Virtual box/VMWare

7.3 Container virtualization: Docker and Kubernetes

7.4 Power shell and windows subsystem for LINUX (WSL)

7.5 Performance optimization and security in virtualized environments

8 Overview of Contemporary OS (3 hours)

8.1 Windows and Linux-based OS

8.2 Embedded and mobile OS

8.3 IoT and RT operating system

8.4 Robot and smart card operating system

Tutorial **(15 hours)**

1. Unix shell programs to do a variety of tasks
2. Problems on scheduling algorithms
3. Problems on page replacement algorithms
4. Problems on deadlock
5. Problems on segmentation and paging
6. Comprehensive study on storage technologies with cost/bit and speed comparisons
7. Study on process management/memory management/IO management/ security/file system of a selected OS

Practical **(22.5 hours)**

1. Basic Unix commands
2. Shell Programming
3. Implementation of the ls and grep commands
4. Programs using the I/O system calls of the UNIX operating system
5. Implementation of scheduling algorithms and the producer-consumer problem using semaphores
6. Implementation of some memory management schemes such as paging and segmentation
7. Term Project

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution*
1	6	8
2	7	10
3	10	13
4	9	12
5	3	4
6	3	4
7	4	5
8	3	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Tanenbaum, A.S., Bos, H. (2024). Modern Operating Systems .3rd Edition. PHI.
2. Stalling, W. (2008). Operating Systems. 6th Edition. Pearson Education.
3. Chaturvedi, A., Rai, B.L. (2017). UNIX and Shell Programming. University Science Press.