Bachelor in Computer Engineering

Year/Part	Code	Subject Type	Subject	Credit	Remarks
II/II	ENSH 252	Core	Numerical Methods	3	
	ENEX 252		Instrumentation	4	
	ENEX 254		Electromagnetics	3	
	ENCT 252		Data structure and Algorithm	3	
	ENCT 253		Data Communication	3	
	ENCT 254		Operating System	3	

Bachelor in Electronics, Communication and Information Engineering

Year/Part	Code	Subject Type	Subject	Credit	Remarks
II/II	ENSH 252	Core	Numerical Methods	3	
	ENCT 251		Discrete structure	3	
	ENEX 252		Instrumentation	4	
	ENEX 253		Computer Organization & Architecture	3	
	ENEX 254		Electromagnetics	3	
	ENEX 255		Signals & Systems	3	

DISCRETE STRUCTURE

ENCT 251

Lecture:3 Year : II
Tutorial:1 Part: II
Practical:0

Course Objectives:
The objective of this course is to provide basic understanding in discrete mathematics and finite state machine. It also emphasizes to build fundamental and conceptual clarity in the area of logic, reasoning, proof, recurrence relation, graph theory, theory of automata and algorithmic analysis.

1. 1. Logic and Induction (8 hours)
   1.1. Review of set theory, relation and function

1.2. Proposition, connectives in proposition, types of propositions, truth function and propositional logjc.
1.3. Expressing statements in logic propositional logic, rules of inference in propositional logic, validity of an argument, methods of tableaux
1.4. Predieate logic and quantification, informal deduction in predicate logic

2. Proof Techniques (5 hours)
   2.1. Formal proofs and informal proofs, mathematical reasoning- direct proof and indirect proof (Proof by contradiction and proof by contraposition)
   2.2. Elementary induction and complete induction, strong induction
   2.3. Proof by counter example, vacuous and trivial proofs, proof by cases, mistakes in proof
3. Automata Theory, Regular Language and Grammar (10 hours)
   3.1. Alphabet, string, string operations and language, introduction to finite automata
   3.2. Deterministic finite automata (DFA), representation and language of DFA
   3.3. Non deterministic finite automata (NFA), equivalence of DFA and NFA
   3.4. Regular expressions and its characteristics, regular language and its properties
   3.5. Equivalence of regular expression and finite automata
   3.6. Context free grammar and context free language
4. Recurrence Relation and Algorithmic Analysis (7 hours)
   4.1. Recurrence relations, recurrence relation for tower of Hanoi (TOH) and Fibonacci series, solving linear recurrence relations (Homogeneous and non-homogeneous)
   4.2. Algorithm and 'its properties, asymptotic notation of algorithm
   4.3. Linear and binary search and their analysis; Bubble and insertion sorting and their analysis
5. Graph Theory and Tree (15 hours)
   5.1. Graphs basics, graph terminologies, graph types (Directed, un-directed, simple, Weighted, regular, complete, bipartite, planar graph) and special graphs
   5.2. Subgraphs, graph representation, connectivity in graphs and its components, strongly and weakly-connected graphs
   5.3. Paths and circuits, Euler path and circuit, Hamiltonian path and circuit
   5.4. Shortest path algorithm (Dijkstra's algorithm), graph coloring and four color theorem, applications of graph colorings
   5.5. Graph as network, maximal flows and minimal cuts, the max flow-min cut theorem
   5.6. Introduction and applications, tree traversals, spanning trees, minimum spanning trees (Prim's and Kruskal's algorithm)

Tutorial (15 hours)

1. Problem related to function, relation and validity of an arguments using rules of inference in propositional and predicate logic
2. Problem related to proof techniques
3. Design of automata, conversion from NFA to DFA, defining grammar for language and properties of regular language
4. Problem related to different recurrence relation including TOHi Fibonacci series and homogeneous and non-homogeneous recurrence relation
5. Representation of graph, finding shortest path, obtaining minimum spanning tree, problems related to planar graph, graph coloring and maximum flow
6. Defining the complexity of liner and binary search, problems related to bubble and insertion sorting algorithms

Final Exam

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

Chapters	Hours	Marks distribution*
1	8	10
2	5	7
3	10	14
4	7	9
5	15	20
Total	45	60

* There may be minor deviation in marks distribution.

References 1. Rosen, K. H. (2019). Discrete Mathematics and Its Applications. United Kingdom: McGraw-Hill.

2. Johnsonbaugh, R. (2007). "Discrete Mathematics", Prentice Hall Inc. Chartrand* G., Oellermanh, O. R. (1993). Applied and Algorithmic Graph Theory. Singapore: McGraw-Hill

4. Lewis, H. R., Papadimitriou, C. H. (1981). Elements of the Theory of Computation. United Kingdom: Prentice-Hall.

5. Cormen, T. H., Leiserson, C. E., Stein, C., Rivest, R. L. (2009). Introduction to Algorithms, Third Edition. France: MIT Press.

INSTRUMENTATION
ENEX 252

Lecture:4 Year: II
Tutorial:1 Part: II
Practical:1.5

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, pneu . tic, 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, 8bit ADC, 8/10bit DAC using mode O and model) with 8085 microprocessors
   4.3 Microcontrollers (Atmega328, STM32): Architecture, pin configuration, and their application
   4.4 Sensor/Actuator interfacing with Atmega328P (Arduino): Analog and digital Sensor's 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, 12C, SPI, CAN
   5.3 Wireless sensor network and •its technology
   5.4 RF modem, Bluetooth, 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 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, 12C, 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. Vo (1999), Microprocessor and Interfacing, Programming and Hardware. Tata McGraw
2. HillGoankar, R. (2000). Microprocessor Architecture, Programming and Application with 8085. Prentice Hall
3. FoWIerj K. Re, (1996). Electronic Instrument Design: Architecting for the Life Cycle. Oxford University Press, Inc,
4. Sawhney, A. K.i (1998). A Course in Electronic Measurement and Instrumentation. Dhanpat Rai and Sons.
5. Gupta, J. B.S (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.

COMPUTER ORGANIZATION AND ARCHITECTURE

ENEX 253

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

Practical: 1.5

Course Objectives:

The objective of this course is to provide the organization, architecture and designing concept of computer system including processor architecture, computer arithmetic, memory system, I/O organization and multicore.

1. 1. Introduction(6 hours)
    - 1.1. Organization and architecture
    - 1.2. Structure and function
    - 1.3. The evolution of computer architecture (RISC, CISC, BERKELEY RISC I, overlapped register window)
    - 1.4. Performance assessment
        - 1.4.1. Clock speed and instruction per second
        - 1.4.2. Instruction execution rate: CPI, MIPS Rate, MFLOPS rate, arithmetic mean, harmonic mean, speed metric, geometric mean, rate metric, Amdahl's law, speed up
    - 1.5. Computer function
        - 1.5.1. Instruction fetch and execute
        - 1.5.2. Instruction cycle state diagram
    - 1.6. Interconnection structure, bus interconnection, multilevel bus hierarchy) PCI
2. Central Processor Organization(6 hours)
    - 2.1. Processor bus organization
    - 2.2. ALU: Arithmetic circuit, logic circuit, one and multi-stage ALU, shifter
    - 2.3. Instruction formats: CPU organization, zero and more address instruction formats
    - 2.4. Addressing modes
    - 2.5. Instruction set
        - 2.5.1. Data transfer instruction
        - 2.5.2. Data manipulation instruction: Arithmetic, logical and shift operations
        - 2.5.3. Program control instruction
    - 2.6. Status bit conditions

3 Control Unit (5 hours)

- 3.1 Definition, block diagram, control signals
- 3.2 Hardwired and microprogrammed CU
- 3.3 Microprogramming approach
- 3.3.1 Control memory and its organization
- 3.3.2 Computer organization
- 3.3.3 Microprogram organization
- 3.3.4 Address sequencing
- 3.3.5 Mapping bf microoperations
- 3.3-6 Microinstruction formats
- 3.3.7 Microprogramming examples
- 3.3.8 Microprogram sequencer
- 3.3.9 Field decoding

4 Memory System (8 hours)

- 4.1 Characteristics of memory system
- 4.2 Memory classification and hierarchy
- 4.3 RAM - (SRAM and DRAM) and ROM organization: Circuit level implementation
- 4.4 Locality Of reference

4.5 Cache memory principle

4.5.1 Cache and main memory

4.5.2 Cache / main memory structure

4.5.3 Cache read operation

45.4 Typical cache organization

45.5 Elements of cache design (Cache address, cache size, mapping techniques, replacement algorithms, write policy, line size, number of caches)

5 Computer Arithmetic (8 hours)

5.1 Integer and floating-point representation

5.2 Integer arithmetic

5.2.1 Addition and subtraction

52.2 Multiplication

5.2.3 Division

5.3 Floating-point arithmetic

5.3.1 Addition and subtraction

5.3.2 Multiplication

5.3.3 Division

6 Pipelining and Vector Processing (4 hours)

6.1 Pipelining concept

6.2 Types of pipelining: Instruction and arithmetic pipelining

The major hurdle and hazards of pipelining: Data, structure and control hazards 6.4 Vector computation

6.2.1 Vector computation approach

6.2.2 Implementation: Pipelined ALU, parallel ALU and parallel processors

7 Input Output (110) Organization (4 hours)

7.1 Peripheral device

7.2 I/O modules

7.3 I/O interface

7.4 Modes of transfer

7.41 Programmed I/O

7.42 Interrupt driven I/O

704.3 DMA

7.5 I/O processor

7.6 Data communication processor

8 Multicore Computer (4 hours)

8.1 Multicore computer

8.2 Hardware performance issues

82.1 Increase in parallelism

8.2.2 Power consumption

8.3 Software performance issue: Software in multicore

8.4 Multicore organization

Tutorial(15 hours)

1. Numerical examples on performance assessment
2. Design of arithmetic circuit, logic circuit and ALU
3. Coding examples covering different instruction formats
4. Microprogramming examples in CU
5. Cache memory mapping: Hit and miss ratio

6. Numerical examples for various arithmetic algorithms

Practical **(22.5 hours)**

1. Programming / simulation for addition and subtraction algorithm
2. Programming / simulation for multiplication algorithm
3. Programming / simulation for division algorithm
4. Programming / simulation for cache mapping technique.
5. Programming / simulation for ALU
6. Programming / simulation for vector processing

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	6	8
3	5	8
4	8	10
5	8	10
6	4	5
7	4	5
8	4	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Stalling, W, (2018). Computer Organization and Architecture. Pearson Education INC.
2. Mano, M. M. (2008). Computer System Architecture. Pearson Education INC. 3. Hennessy, J. L. Patterson D. A., (2000). Computer Architecture - A Quantitative Approach. Harcourt Asia PTE Ltd.

ELECTROMAGNETICS

ENEX 254

Lecture:3 Year
Tutorial:1 Part : II
Practical1.5

Course Objectives:
The objective of this course is to provide students with a basic mathematical concept 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)
- 21 Coulomb's law
- 2.2 Electric field intensity
- 2.3 Electric flux density
- 2.4 Gauss's law and applications
- 25 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 (22S 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 measurements usin 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.

SIGNALS AND SYSTEMS

ENEX 255

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

Practical :1.5

Course Objectives:

The objective of this course is to provide students with a fundamental understanding of how signals are represented, analyzed, and processed in various systems. Students will grasp essential concepts such as signal classification, time and frequency domain analysis, convolution and Fourier analysis. By the end of the course, students should be proficient in solving problems related to signal processing and system analysis, enabling them to design and optimize systems effectively.

1. Signal and its Types(7 hours)
   - 1.1. Introduction to signal and signal processing
   - 1.2. Classification of signal based on dimension
   - 1.3. Classification of one-dimensional signal (CT and DT) and properties
   - 1.4. Fundamental signals: Delta function, unit step, ramp, rectangular pulse, signum function
   - 1.5. Relationship between unit step and delta function
   - 1.6. Signal classification based on causality
   - 1.7. Classification of signals based on periodicity (CT and DT)
   - 1.8. Transformation of the independent variable
   - 1.9. Energy and power signals
   - 1.10. Even and odd signals
   - 1.11. System, types of systems: Linear and non-linear, causal and non-causal, timeinvariant and time-variant
2. Fourier Series (9 hours)
   - 2.1. Introduction to Fourier series
   - 2.2. Fourier series representation of continuous time periodic signal
   - 2.3. Properties of continuous time Fourier series: Linearity, time shifting time scaling, time reversal, convolution, multiplication, frequency shifting, conjugate symmetry, Parseval's relation
   - 2.4. Fourier series representation of discrete time periodic signal
   - 2.5. Properties of discrete time Fourier series: Linearity, time shifting, time scaling, time reversal, convolution, modulate conjugate symmetry, Parseval's relation 2.6. Applications of Fourier series
3. Fourier Transform (9 hours)
   - 3.1. Introduction to Fourier transform
   - 3.2. Continuous time Fourier transform
   - 3.3. Properties of continuous time Fourier transform: Linearity, time shifting, frequency shifting, time scaling, time reversal, convolution, multiplication, duality, conjugation, Parseval's relation
   - 3.4. Discrete time Fourier transform

3.5. Properties of discrete time Fourier transform: Linearity, time shifting, frequency shifting, time reversal, convolution, modulation, conjugation, Parseval's relation
3.6. Fourier transform for periodic signals
3.7. Applications of Fourier transform

4. Linear Time Invariant (LTI) System (7 hours)
   4,1 Linear time invariant (LTI) system
   4.2 Convolution integral properties of LTI system
   4.3 Representation of discrete-time signals in terms of impulses –
   4.4 4.4 -Convolution sum
   4.5 Representation of continuous-time signals in terms of impulses
   4.6 Convolution integral
   4.7 Practical applications of convolution
5. Sampling (6 hours)
   5.1. Introduction to sampling
   52 Sampling theorem
   5.3 Practical consideration of sampling and impulse-train sampling
   5.4 Signal reconstruction from sampled version
   5.5 Aliasing
   5,6 Band limited signals
6 Frequency Response of Continuous and Discrete Time Systems (7 hours)
   6.1 Frequency response of continuous time systems
   6.2 Transfer function of continuous time system
   6.3 Impulse response of ideal low-pass, band-pass and high-pass filter
   6.4 Response of ideal low pass filter to a step function input
   6.5 Frequency and Impulse response of RC filter
   6.6 Frequency response of discrete time systems: Transfer function
   6.7 Impulse response of low-pass, band-pass and high-pass filter

Tutorial (15 hours)

1. Numerical related to signal construction and periodicity
2. Numerical related to extraction of even and odd part of both continuous and discrete time signals
3. Numerical to calculate the energy and power of both continuous and discrete time signals
4. Numerical related to Fourier series and its properties
5. Numerical related to Fourier transform and its properties
6. Numerical exercise to compute convolution sum and convolution integral
7. Numerical related to sampling and aliasing and signal reconstruction

Practical (22.5 hours)

1. Generation of continuous time sinusoidal signal, continuous time unit step signal, discrete time unit step signal, continuous time ramp signal, continuous time sinc

function, discrete time sinusoidal signal, discrete time unit step signal, discrete time unit impulse signal, continuous time exponential signals, discrete time exponential signals, continuous time complex exponentials and discrete time complex exponentials

2. Convolution: Square wave with odd symmetry
3. Magnitude and phase of rational signal
4. Fourier series
5. Fourier transform

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	9	12
3	9	12
4	7	10
5	6	7
6	7	9
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Oppenheim, A.V., Willsky, A.S., Nawab, S.H. (2013). Signals and Systems. Pearson education second edition.
2. Oppenheim, A., Schafer, R. W. (2013). Discrete-Time Signal Processing: Pearson New International Edition. United Kingdom: Pearson Education.
3. Ingle, V. K., Proakis, J. G. (2000). Digital signal processing using MATLAB. United Kingdom: Brooks/Cole. 4. Lathi, B. P. (2010). Linear Systems and Signals United Kingdom: Oxford University Press.

NUMERICAL METHODS
ENSH 252

Lecture:3 Year : II
Tutoriai: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 Mattix inverse using Gauss Jordan and Gauss elimination methods
      2.1.4 Factorization methods (Do-Little[f]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

3.22 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

42.1 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

6.32 Poisson's equation

6.4 Solution of parabolic and hyperbolic equations

6.4.1 One-dimensional heat equation: Behdre-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-Seide 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 / 2nd order ODE
   - Solution of' two-point boundary value problem using Shooting method Solution of twopoint 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-Sejdal iteration
   - One-dimensional heat equation using Bendre-Sdhmidt 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

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4. Yakowitz, S., Szidarovszky, F. (1986). An Introduction to Numerical Computations (2nd edition). Macmillan publishing.
5. Kong, Q., Siauw T., Bayen. (2020). Python Programming and Numerical Methods. Academic Press