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Department of Electronic Science

Semester-III

DISCIPLINE SPECIFIC CORE COURSE – 7: Engineering Mathematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Engineering Mathematics ELDSC-7	4	3	-	1	Course Admission Eligibility	-

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide the students with the skill and knowledge to perform calculations for solutions to the problems related to various topics that they would be taught during the course of this programme.
- To prepare the students with the mathematical tools they would require while studying and analysing problems in electronics networks, electronic and optical communications, semiconductor devices such as transistors, diodes, transient circuits in power devices, and problem solving in Electromagnetic theory, waveguides, and antennas.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use mathematical tools to solve/model the problems related to Electronics
- Solve linear differential equations using a variety of techniques, power series method and special functions
- Understand to solve N coupled equations using matrices, concept of Eigen values and Eigen vectors
- Familiarize with the concept of sequences and series, convergence and divergence
- Appreciate the complex variables and perform operations with complex numbers

SYLLABUS OF ELDSC-7 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Ordinary Differential Equations(ODE): Introduction to First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations.

Series Solutions of ODE: Power Series method, Legendre Polynomials, Bessel's equations and Frobenius method.

Special functions: Beta and gamma functions, error functions

UNIT – II (11 Hours)

Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Solution of a system of Linear equations by LU decomposition, Gauss Jordan and Gauss-Seidel Method. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices. Real and Complex Matrices.

Matrix Eigen Value Problems: Linear transformation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors.

UNIT – III (11 Hours)

Sequences and Series: Sequences and its kind, Limits of a sequence, Convergent, Divergent and oscillatory sequences.

Convergence of Infinite series, Tests of Convergence: Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series Test.

UNIT – IV (11 Hours)

Complex Variables Analysis: Complex Variables, Complex functions, Continuity, Differentiability, Analyticity, Cauchy-Riemann (C-R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Functions, Trigonometric Functions, Hyperbolic Functions.

Complex Integration: Line integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula. Taylor series-exponential, logarithmic and trigonometric functions.

Practical component (if any) – Engineering Mathematics
(Scilab/MATLAB/ any other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform operations with various forms of complex numbers to solve equations
- Use mathematics as a tool for solving/modeling systems in electronics
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Solution of First Order Differential Equations
2. To test convergence of a given series.
3. To test divergence of a given series.
4. Solution of linear system of equations using Gauss Elimination method.
5. Solution of linear system of equations using Gauss – Seidel method.
6. Solution of linear system of equations using L-U decomposition method.
7. Plots of the exponential, logarithmic and trigonometric functions and comparison with the plots of their Taylor series expansion till first 10 terms

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than six.

Essential/recommended readings

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2010), 10th Edition
2. Murray Spiegel, Seymour Lipschutz, John Schiller, Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill (2009), 2nd Edition
3. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
4. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill (2006)

Suggestive readings

1. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8: Analog Electronics-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analog Electronics-II ELDSC-8	4	3	-	1	Course Admission Eligibility	Basic knowledge of BJT based circuits

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop understanding of Analog Devices starting with ideal Op Amp model and assessing the practical device limitations and learning importance of the Data Sheets.
- Design linear applications but also design of non-linear application without feedback (voltage comparators), with positive feedback (Schmitt Trigger), and the negative feedback but using non- linear elements such as diodes and switches (sample and hold circuits)
- Study of Oscillators and other Signal Generators
- Study Multivibrators and its applications using IC 555 Timer

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basic building blocks of an op-amp and its parameters for various applications design.
- Elucidate and design the linear and non-linear applications of an op-amp.
- Understanding and Designing of various Signal Generators
- Understand the working of multivibrators using IC 555 timer

SYLLABUS OF ELDSC-8 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Basic Operational Amplifier: Concept of differential amplifiers (Dual Input Balanced and Unbalanced Output), Block Diagram of an Operational Amplifier, Characteristics of an Ideal Op-Amp.

Open and Closed Loop Configurations: Inverting, Non-Inverting and Differential Amplifier

Op-Amp Parameters (IC741): Differential Input Resistance, Output Resistance, Input Capacitance, Input Voltage Range, Large Signal Voltage Gain, Offset Voltage Adjustment Range, Input Offset Voltage, Input Offset Current, Input Bias Current, Common Mode Rejection Ratio, Supply Voltage Rejection Ratio, Bandwidth, Gain Bandwidth Product, Slew Rate.

UNIT – II (11 Hours)

Frequency Response of an Op-Amp.: High Frequency Op-Amp Equivalent Circuit, Open Loop Voltage Gain as a function of Frequency, Closed Loop Frequency Response, Effect of Slew Rate in Applications.

Linear Applications of an Op-Amp: Summing, Scaling and Averaging Amplifiers, Subtractor, Integrator, Differentiator, Current to voltage converter.

UNIT – III (11 Hours)

Active Filters: First Order Low Pass and High Pass Butterworth Filter, Concept of Higher Order Butterworth Filters, Band Pass Filter, Band Reject Filter, All Pass Filter.

Non-Linear Applications of an Op-Amp: Basic Comparator, Level Detectors, Schmitt Trigger, Characteristics of Comparator, Voltage Limiters, Sample and Hold circuit.

UNIT – IV (11 Hours)

Signal Generators: Phase Shift Oscillator, Wien Bridge Oscillator, Square Wave Generator, Triangle Wave Generator, Saw Tooth Wave Generator

IC 555 Timer: Block Diagram, Astable and Monostable Multivibrator Circuit, Applications of Monostable and Astable Multivibrator.

Practical component (if any) – Analog Electronics- II
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the non-ideal behaviour by parameter measurement of Op-amp.
- Design application oriented circuits using Op-amp ICs.
- Generate square wave using different modes of 555 timer IC.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an Op-Amp.
3. Designing of an Integrator using op-amp for a given specification.
4. Designing of a Differentiator using op-amp for a given specification.
5. Designing of analog adder/subtractor circuit.
6. Designing of a First Order Low-pass / High Pass Filter using op-amp and study its frequency response.
7. Designing of a RC Phase Shift Oscillator using Op-Amp.
8. Study of IC 555 as an astable multivibrator.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits , Pearson Education
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education
3. Nutan Kala Joshi and Swati Nagpal, Basic Electronics, Khanna Publishers

Suggestive readings

1. D.Roy Choudhary and Shail B. Jain, Linear Integrated Circuits, New Age International Publishers
2. A.P.Malvino, Electronic Principals, Tata McGraw-Hill

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9: Signals and Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Signals and Systems ELDSC-9	4	3	-	1	Course Admission Eligibility	-

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand mathematical description and representation of continuous and discrete time signals and systems.
- Develop input-output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
- Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in *s*- domain.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Represent various types of continuous-time and discrete-time signals and their convolution.
- Understand concept of convolution, LTI systems and classify them based on their properties and determine the response of LTI system.
- Determine Fourier series of periodic signals.
- Analyze various systems using Fourier and Laplace transformations.

SYLLABUS OF ELDSC-9 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Signals and Systems: Continuous and discrete time signals, time domain operations (shifting, scaling, reflection, *etc.*) with precedence rules. Exponential and sinusoidal signals, impulse and unit step functions, continuous-time and discrete-time systems and their basic properties.

UNIT – II (11 Hours)

Linear Time -Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative. LTI systems with and without memory, invariability, causality, stability, unit step response. Differential and Difference equation formulation. Block diagram representation of first order systems.

UNIT – III (12 Hours)

Fourier series Representation of Periodic Signals: Fourier series representation of periodic continuous and discrete signals. Convergence of the Fourier series (Dirichlet conditions).

Fourier Transform: Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and multiplication Properties, Properties of Fourier transform and basic Fourier transform Pairs.

UNIT – IV (11 Hours)

Laplace Transforms: Unilateral Laplace transform, inverse Laplace transform, properties of the Laplace transform, Laplace transform pairs, Laplace transform for signals. Solutions of first and second order differential equations with initial conditions.

Practical component (if any) – Signals and Systems
(Scilab/MATLAB/ OCTAVE/Other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Generate/plot various signals, there transformation and compute convolution
- Generate/plot Fourier series of periodic signals.
- Compute Fourier transform
- Learn the use of simulation tools and design skills.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Plotting/generation of signals: continuous time
2. Plotting/generation of signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of signals
5. Fourier series representation of continuous time signals.
6. Fourier series representation of discrete time signals.
7. Computation of Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
2. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007).

Suggestive readings

1. S. Haykin and B. V. Veen, Signals and Systems, John Wiley & Sons (2004).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Artificial Intelligence and Machine Learning ELDSE-1A	**4**	**3**	**-**	**1**	**Course Admission Eligibility**	**Basic knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:
Artificial Intelligence and Machine Learning has emerged as one of the most rapidly growing technology sector in today's time. This fascinating technology area which deals with designing 'machines which can think' is finding widespread application in almost every industrial and domestic sector. Advancement in the field of AI and ML has also led to complete revolution in the other technology areas including Robotics, embedded systems and Internet of Things. AI and ML is considered to be one of the major contributor to the paradigm shift in technology which has taken place over the past few decades, which is very similar in scale to past events such as the industrial revolution, the computer age, and the smart phone revolution.
This course will give an opportunity to gain expertise in one of the most fascinating areas of science and technology through a well-structured classroom program that covers almost all the topics related to designing machines which can replicate human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence and Machine Learning.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Build intelligent agents for search and games
- Solve AI problems through programming with Python
- Learning optimization and inference algorithms for model learning

- Design and develop programs for an agent to learn and act i
  structured environment
- To study different supervised and unsupervised learning algorithms.
- To understand the application development process using ML
  .

SYLLABUS OF ELDSE-1A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Concept of AI, history, current status, scope, Modeling Techniques: Turing Test Approach, Cognitive Modeling Approach, Rational Agent Approach and Laws of Thought Approach, AI System Architecture: Concept of Agent & Environment, Types of Agents: Reactive Agent, Model based Reflex Agent, Omniscient Agent, Goal Based Agent, Utility based Agent and Learning Agent, Knowledge based Agents and Knowledge Representation Techniques. Types of Environment, PEAS representation of Intelligent Agents, Problem Solving Agents, AI Problem Formulation, State space representation

UNIT – II (11 Hours)

Search Algorithms: Uninformed Search Algorithms: Breadth first search, Depth First Search, Depth Limited Search, Uniform Cost Search and Bidirectional Search, Heuristic Search Algorithms: concept of Heuristic Function, Greedy Best First Search, A* search algorithm, Game Search Algorithms: Minimax Search Algorithm and Alpha-Beta Pruning.

Simple AI problems (such as Water Jug Problem, Maze Problem, 8-Tile Puzzle problem, Traveling Salesman Problem).

UNIT – III (11 Hours)

Probabilistic Reasoning Model: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability, Markov Model and Hidden Markov model.

Markov Decision Process Model: MDP formulation, Elements of MDP Model, concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world

UNIT – IV (12 Hours)

Machine Learning: Types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Supervised Learning Vs. Unsupervised Learning **Supervised Learning Techniques:** Regression Analysis, Linear Regression, Classification Algorithm, Logistic Regression, K-NN Algorithm, Classification Vs. Regression, Linear Regression Vs. Logistic Regression, Decision Tree Classification Algorithm, Random Forest Algorithm, Clustering in Machine Learning, Hierarchical Clustering in Machine Learning, K-Means Clustering Algorithm

Practical component (if any) – Artificial Intelligence and Machine Learning *(Python software)*

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement various search algorithms
- Implement Bayesian network
- Demonstrate classification and clustering
- Make a small project

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to solve the given search tree using Breadth First Search
2. Write a program to solve the given search tree using Depth First Search and Depth Limited Search
3. Write a program to solve the given search tree using Uniform Cost Search
4. Write a program to solve the given search tree using Greedy Best First Search
5. Write a program to solve the given game search tree using Minimax Search
6. Program for construction and inference of a Bayesian network
7. Write a Program to perform Regression on given data sets
8. Write a Program to demonstrate Classification
9. Write a Program to demonstrate Clustering
10. Mini Project work

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Stuart Russell and Peter Norvig, ―Artificial Intelligence: A Modern Approach‖ , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Tata McGraw Hill
3. Trivedi, M.C., ―A Classical Approach to Artificial Intelligence‖, Khanna Publishing House, Delhi.
4. Saroj Kaushik, ―Artificial Intelligence , Cengage Learning India, 2011
5. Introduction to Machine Learning with Python, by Andreas C. Müller, Sarah Guido, O'Reilly Media, Inc., 2016

Suggestive readings

1. David Poole and Alan Mackworth, ―Artificial Intelligence: Foundations for Computational Agents, Cambridge University Press 2010
2. Machine Learning by Tom. M. Mitchell, Tata McGraw Hill
3. Introduction to Machine Learning by Nils. J. Nillson

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algorithm Design and Analysis ELDSE-1B	4	3	-	1	Course Admission Eligibility	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the understanding of usage of basic data structures like stack, queue, linked list, trees
- To introduce the students to design and analyse algorithms
- To highlight the differences between various problem-solving techniques for an efficient algorithm design
- To provide an understanding of algorithm design through a survey of the common algorithm design paradigms of Iterative techniques, Divide and Conquer, Dynamic Programming, Greedy Optimization
- To develop proficiency in Problem Solving and Programming
- To provide an understanding of time and space complexities of algorithms designed to solve computational problems
- To familiarize with various Searching and Sorting techniques

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement data structures like Stacks, Queues. Linked List, trees
- Use an appropriate algorithm using the algorithm design techniques, namely,
- Iterative, Divide and Conquer, Greedy, Dynamic Programming for a series of
- computational problems
- Apply various Searching and Sorting techniques
- Solve computational problems with an understanding of time and space complexities of algorithms

SYLLABUS OF ELDSE-1B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Data Structures: Stacks, array implementation of stack, operation on stacks, application of stacks-conversion of infix expression to prefix and postfix, evaluation of expression; Queues, array implementation of queues, operation on queues, Linked List and its implementation of stack and queue.

UNIT – II (11 Hours)
Trees: Introduction to trees, Binary search tree, preorder, postorder and inorder traversal (recursive)
Searching Techniques: Linear and Binary Search, Hashing techniques

UNIT – III (12 Hours)
Algorithm Design Techniques: Iterative techniques-Insertion Sort, Divide and Conquer-Merge Sort, Dynamic Programming-Weighted Interval Scheduling, 0-1 Knapsack Problem

UNIT – IV (11 Hours)
Greedy Algorithm- Interval Scheduling, Fractional Knapsack problem, Dijkstra's shortest path problem. Comparison between Dynamic programming and Greedy algorithm
Sorting Techniques: Quick Sort, Heap sort, Sorting in Linear Time - Bucket Sort, Radix Sort and Count Sort, Time and Space complexity

Practical component (if any) – Algorithm Design and Analysis
(Python/MATLAB software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement Data Structures
- Develop algorithms and write programs in Python language
- Write programs based on Algorithm design techniques
- Implement various Sorting techniques
- Prepare a Technical Report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to create a stack and perform Pop, Push, traverse operations on the stack using Linear Linked List
2. Program to create a linear queue using Linked List and implement insertion, deletion and display of the queue elements
3. Program to create a Binary Tree to perform traversals (Preorder, Postorder, Inorder) using the concept of recursion.
4. Program to solve the Interval Scheduling problem
5. Program to solve the Weighted Interval Scheduling problem
6. Program to solve the 0-1 Knapsack problem
7. Program to implement Insertion Sort
8. Program to implement Merge Sort
9. Program to implement Heap Sort
10. Program to implement Quick Sort

11. Program to implement Bucket Sort
12. Program to implement Radix Sort
13. Program to implement Binary Search

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven.

Essential/recommended readings

1. M.T.Goodrich, R.Tamassia, M.H.Goldwasser, Data Structures & Algorithms, Wiley
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Prentice Hall India. Third edition (2015).
3. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education India, First Edition (2013).
4. S. Lipschutz, Data Structures with C, Schaum's Outlines Series, Tata McGraw Hill
5. A.M.Tenenbaum, Y.Langsam, M.J. Augenstein, Data Structures using C, Pearson/PHI

Suggestive readings

1. Sarabasse and A.V. Gleder, Computer Algorithm-Introduction to Design and Analysis, Pearson Education, Third Edition (1999).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematics Foundation for Computing ELDSE-1C	4	3	-	1	Course Admission Eligibility	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:

- The aims is to introduce to students of electronics new mathematics such as Boolean algebra, relations, and graph theory which though look abstract concepts can be used effectively to design and analyze electronic circuits.
- To apply mathematical techniques for real world and engineering problems and expose students to some front-line techniques used in industry and academics.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Formulate recurrence relations to solve problems involving an unknown sequence. Student should see the significance in light of the Forbenius method they learn.
- Use Boolean algebra to design and analyze digital switching circuitry, such as found in personal computers, pocket calculators, CD players, cellular telephones, and a host of other electronic products.
- Appreciate circuit analysis in terms of topology.

SYLLABUS OF ELDSE-1C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Elementary Combinatorics: Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formula.

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

UNIT – II (10 Hours)

Recurrence Relations: Recurrence Relations, generating functions, iteration and induction, Linear Recurrence Relations with constant coefficients and their solution, Substitution Method, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

UNIT – III (11 Hours)

Boolean Algebras and Switching Circuits: Axioms of Boolean Algebra, De Morgan's law, Simplification of Boolean Expressions, Representation theorem, Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial,3, 4 and 5 variable Karnaugh diagrams, Quine-McCluskey method, Switching circuits and applications of switching circuits.

UNIT – IV (12 Hours)

Graph Theory: Introduction to Graph Theory with emphasis on DC circuit analysis, Representing circuital network as a graph, identification of branches, nodes, Tree branch/ twig. Formulation of incidence matrix. Usage of incidence matrix to solve for node voltage in two loop DC circuits with voltage and/ or current sources.

Practical component (if any) – Mathematics Foundation for Computing
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement python programs to calculate permutation and combinations.
- Write python programs based on Boolean Algebra and Minimize Karnaugh diagrams
- Should be able to do node analysis using incidence matrix/ Graph Theory.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Write a program that generates all the permutations of a given set of digits (with or without repetitions).
2. Write a program to generate Fibonacci Series using recursion.
3. Write a program to implement binary search using recursion.
4. Write a Program to accept the truth values of variables x and y, and print the truth table of the following logical operations:
    a. Conjunction
    b. Disjunction
    c. NAND
    d. NOR
    e. Exclusive OR
    f. Exclusive NOR
    g. Negation

5. Determine node voltages of given two loop circuits using given incidence matrix.

Essential/recommended readings

1. V. Krishnamurthy, Combinatorics, Theory and Application, Affiliated East-West Press 1985.
2. C.L. Liu & Mahopatra, Elements of Discrete mathematics, 2nd Sub Edition 1985, Tata McGraw Hill
3. G. Langholz, A. Kandel and J. Mott, Foundations of Digital Logic Design, World Scientific, Singapore, 1998.
4. Kenneth H. Rosen. Discrete Mathematics and Its Application. McGraw-Hill Education, Pennsylvania, U.S.A, 2011.
5. M.O. Albertson and J.P. Hutchinson, Discrete Mathematics with Algorithms, John Wiley and Sons (USA, 1988).

Suggestive readings

1. T.H. Coremen, C.E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice Hall India (3rd edition 2009)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT

GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Circuits and Interfacing ELGE-3A	**4**	**3**	**-**	**1**	**-**	**-**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the basics of operational amplifier and it's linear and nonlinear applications.
- To familiarize IC 555 Timer and its application
- Understand the working of multivibrators
- To understand working of various types of transducers.
- To introduce concept of embedded systems using Arduino.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with design of the linear and non-linear applications of an op-amp.
- Understand the working of multivibrators
- Understand working of various types of transducers.
- Understand working of Arduino

SYLLABUS OF ELGE-3A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Basic Operational amplifiers: Block diagram, symbol, op- amp parameters (IC 741).

Op -Amp Circuits: Closed loop Inverting, Non-inverting, Summing and difference amplifier, Integrator, differentiator, Instrumentation Amplifier, Audio Amplifier (LM386) Voltage to current converter.

Comparators: Basic comparator, Schmitt Trigger.

UNIT – II (11 Hours)

Signal Conditioning Circuits: Active filters: First order Butterworth low pass and high pass filter, Wide Band -Pass filter, Wide Band-Reject filter, All-Pass filter (Designing with Circuit diagrams and formulas only for all filter)

Signal Generators: Phase shift oscillator, Wein Bridge oscillator (Designing with Circuit diagrams and formulas)

Multivibrators (IC 555): Block diagram, Astable and Monostable circuit. Applications of Astable and Monostable multivibrators.

UNIT – III (11 Hours)

Transducers (Basic Working): Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge),Capacitive (diaphragm), Hall effect sensors, Microphone, Touch Switch, Piezoelectric sensors, light (photoconductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), Pressure sensor.

UNIT – IV (11 Hours)

A-D and D-A Conversion: D-A conversion: 4-bit binary weighted resistor type, circuit and working. Circuit of R-2R ladder- Basic concept. A-D conversion characteristics (Number of channels, resolution), successive approximation ADC. (Mention the relevant ICs for all).

Data Acquisition using Arduino: Arduino: Birth, Open-Source community, Functional Block Diagram, Functions of each Pin, Applications of Arduino, IDE, Basic Interfacing and I/O Concept, Interfacing LED, Switch,7seg LED.

Practical component (if any) – Electronic Circuits and Interfacing
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Design application-oriented circuits using Op-amp.
- Design application-oriented circuits using timer IC
- Familiarization with different specifications of arduino boards.
- Interfacing of various sensors with arduino.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Study of inverting and non-inverting amplifier.
2. Study of analog adder/ subtractor circuit.
3. Study of basic integrator circuit/ basic differentiator circuit.
4. Design of first order LPF / first order HPF.
5. Study of basic astable multivibrator / monostable multivibrator.
6. 555 Timer-Rain alarm /Motor control by PWM /LED flasher circuit.

7. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement Strain using half and full bridge.)/ To determine the Characteristics of LVDT.
8. To determine the Characteristics of Thermistors and RTD.
9. Test the different Arduino Boards, Open-Source and Arduino Shields and install Arduino IDE and its development tool.
10. Develop a program to Blink LED for 1second when switch is pressed.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Measurement Systems, 4/e, Doeblin McGraw Hill, New York, 1992.
2. Electrical Measurements & Electronic Measurements by A.K. Sawhney
3. Electronic Instrumentation by H.S Kalsi, McGraw Hill
4. R. A. Gayakwad, Op-Amps and Linear IC‗s, Pearson Education (2003)
5. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.
6. Beginning Arduino Programming, Brian Evans, Technology in Action

Suggestive readings

1. Instrumentation- Devices and Systems by Rangan, Sarma, and Mani, Tata-McGraw Hill
2. Instrumentation measurements and analysis by Nakra & Choudhary
3. Measurement & Instrumentation- DVS Murthy
4. Timer, Op Amp, and Optoelectronic Circuits & Projects, Forrest M Mims, Master Publishing Inc.
5. Exploring Arduino, Jeremy Blum, Wiley
6. Beginning Arduino, Michael McRobetrs, Technology in Action
7. Practical Arduino Engineering, Harold Timmis, Technology in Action
8. Practical Arduino: Cool Projects for open-source hardware, Jonathan Oxer, Hugh Blemings, Technology in Action

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Modelling and Simulation ELGE-3B	4	3	-	1	-	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:
It covers modeling and simulation principles as applied to engineering and social sciences. It discusses the techniques for modeling a simple to slightly complex system and perform statistical analysis. It covers about the steps involved in developing models for static, continuous and discrete systems. It also offers the introduction to number of latest models and simulation tools being used in industry with a set of examples. Examples may include modeling and analysis of manufacturing systems, computer-communication networks, operating system and various utilities and logistic systems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Enable to perform simulations for developing models in order to solve problems in static and dynamic systems.
- Evaluate simulation models and do the analysis of a number of systems existing in real life.
- Synthesize queuing theory, random numbers generators and their application to modeling and simulation.

SYLLABUS OF ELGE-3B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Introduction to Modeling and Simulation: Introduction and historical development in Modeling and Simulation. System, Model and Simulation. Real system vs. Model of the system. Analytical solution vs. Simulation. Static vs. Dynamic Simulation Models. Continuous time vs. Discrete time modeling system. Hybrid systems, Feedback systems, Iterative systems Modeling. Random numbers in Simulation, random variables with discrete and continuous probability distribution. Deterministic and Stochastic Modeling System. Mathematical Modeling & Mathematical Tools.

UNIT – II (11 Hours)

Modeling Techniques and Design Steps: Discrete Event Simulation Models. System Models and Events. State variables, Entities and Attributes. Steps of Model Designs, Verification, validation and calibration of the Model.
Single server Queuing system, Database server as Queuing System.
Monte Carlo Method for static System.
Discrete and continuous Markov Models.

UNIT – III (11 Hours)
Simulation Techniques and Specifications: Advantages and disadvantages, Limitations, Steps in Simulation Study.
Differential Equation System Specification DESS, Discrete Event System Specification DEVS, Discrete Time System Specification DTSS.
Random numbers in Simulation. Random numbers generation and testing, Random variables with Discrete and continuous probability distribution. Simulation with Mathematical Models, Stochastic Models

UNIT – IV (11 Hours)
Modeling and Simulation Tools with Applications: System development, Project planning, System definition, Model formulation, input data collection and analysis, Model translation, verification and validation, experimentation and Analysis.
Different Applications domain of Modeling and Simulation.
Case Studies: Simulation of DEVS in a Bank, School, Hospital, or any such system. Modeling and analysis of a manufacturing systems, grocery store, computer-communication network or CPU scheduling.

Importance of different Modeling and Simulation softwares and their selection.
Brief overview and usefulness of Modeling and Simulation softwares- Scilab, SPICE, VHDL, Freemat, IMODELER, platform JModelica.org, Statistical Analysis Software SAS, MS- Excel.

Practical component (if any) – Modelling and Simulation
(Python or any Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Program for implementation, testing of random numbers
- Simulation of gaming dice
- Different Models implementation- GPSS, DEVS
- Implementation of DESS, Monte Carlo Method, Markov Chain
- Simulation of real time problems

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Implement different methods of random number generation
2. Simulating games of dice that generate discrete random variate, using random number generation

3. GPSS models - queue, storage, facility, multi-server queue, decision making problems
4. Perform an experiment on Testing of random numbers.
5. Write a simulator for any DEVS model that has scalar real values for its inputs, states and outputs.
6. Define a DEVS counter that counts the number of non-zero input events received since initialization and outputs this number when queried by a zero valued input.
7. Formulate a causal simulator for multi-component DESS.
8. Implementing an application of Monte Carlo methods.
9. Implement an application of Markov's chain.
10. Simulation of single queue server system.
11. Study of an implemented goal programming system and on decision making tools.
12. Study of a Game theory problem and solution.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than ten.

Essential/recommended readings

1. Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman, 3ed, Theory of Modeling and Simulation, Academic Press : Elsevier 1985.
2. Narsingh Deo, System Simulation with Digital Computers, Prentice Hall of India, 1979.
3. Geoffrey Gordon, System Simulation, 2ndEd., PHI, 1987
4. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, 3rdEd., Tata McGraw Hill, 2003

Suggestive readings

1. Raj Jain, Art of Computer Systems Performance Analysis, John Wiley and Sons, Inc,1991
2. Sheldon M. Ross, Simulation, 4thEd., Elsevier 2008
3. Jerry Banks and John S. Carson, Barry L Nelson, Discrete-Event System Simulation, 5thEd., Prentice Hall, 2010

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.