UNIVERSITY OF DELHI

CNC-II/093/1(40)/EC-1270/2024-25/174
Dated: 12.08.2024

NOTIFICATION

Sub: Amendment to Ordinance V

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Faculty of Technology

1. The course structure, curriculum and syllabi of following programmes under Faculty of Technology [ECR No. 5-28/ dated 27.07.2024]:

   (i) Course Structure, Curriculum and Syllabi of B.Tech (Electronics & Communication Engineering) Second Year – **Annexure-1**
   (ii) Course Structure, Curriculum and Syllabi of B.Tech (Electrical Engineering) Second Year – **Annexure-2**
   (iii) Course Structure, Curriculum and Syllabi of B.Tech (Computer Science & Engineering) Second Year – **Annexure-3**
   (iv) Development of minor in a discipline or development of specialization – **Annexure-4**

2. The syllabus of following AEC papers to be offered to the students of B.Tech under Faculty of Technology [ECR No. 5-10/ dated 27.07.2024]:

   (i) AEC –हिंदी भाषा और तकनीक – Details are at **Annexure-5**
   (ii) AEC –Sanskrit Language and Technology - Details are at **Annexure-6**

REGISTRAR

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Course Structure and Curriculum of B.Tech. (ECE) Second Year

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Course Structure of B. Tech (ECE) Second Year
Second Year

Semester – III

S. No.	Course Domain	Course Title	Credits*			Total Credits
			L	T	P	
1.	DSC-7	Electronic Devices and Circuits	3	0	1	4
2.	DSC-8	Network Analysis and Synthesis	3	0	1	4
3.	DSC-9	Digital Electronics - I	3	0	1	4
4.	DSE-1 or GE-3	Select a course from the specified list of DSE-1 or Select a course from the specified list of GE-3				4
5.	AEC	Select a course from the specified list of AECs				2
6.	SEC or IAPC	Choose one SEC or Internship/Apprenticeship/Project/Community Outreach (IAPC)				2
7.	VAC	Select a course from the specified list of VACs				2
Total Credits						22

Semester – IV

S. No.	Course Domain	Course Title	Credits*			Total Credits
			L	T	P	
1.	DSC-10	Signals and Systems	3	0	1	4
2.	DSC-11	Electromagnetic Theory (EMT)	3	0	1	4
3.	DSC-12	Linear Integrated Circuits	3	0	1	4
4.	DSE-2 or GE-4	Select a course from the specified list of DSE-2 or Select a course from the specified list of GE-4				4
5.	AEC	Select a course from the specified list of AECs				2
6.	SEC or IAPC	Choose one SEC or Internship/Apprenticeship/Project/Community Outreach (IAPC)				2
7.	VAC	Select a course from the specified list of VACs				2
Total Credits						22

**Credits*
L (01 Credit) is equivalent to 01 contact hour per week
T (01 Credit) is equivalent to 01 contact hour per week
P (01 Credit) is equivalent to 02 contact hours per week

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Pool of DSEs offered by the Department

S. No.	Semester	DSE	Course Title
1.	III	DSE - 1	Computational Methods
2.			PCB based System Design
3.	IV	DSE - 2	Interfacing Electronics
4.			Modeling Electronic Circuits

List of SECs offered by the Department

S. No.	Semester	Course Title
1.	III	Advanced Electronics Workshop
2.	IV	SimCircuits Workshop

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Specialization and Minors offered by the Department

Semester	DSE/ GE	ECE Minor (Open only for CSE/ EE)	Specializations for ECE/ Minors for EE and CSE			
			Telecommunication Networks	VLSI Technology and System Design	IoT System Design	Computer Vision
III	DSE-1/ GE-3	Fundamentals of Analog Electronics	Introduction to Analog Communication	VLSI Technology and Design	Introduction to IoT	Fundamentals of Image Processing
IV	DSE-2/ GE-4	Introduction to Signals and Systems	Fundamentals of Digital Communication	Microelectronics Design	Introduction to IoT System Design	Image Filtering and Restoration

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Core (DSC) Courses for B. Tech. (ECE) – Semester 3

Electronic Devices and Circuits (DSC - 7)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electronic Devices and Circuits	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To introduce basic semiconductor devices, their characteristics and their application
- To understand the analysis and design of a simple diode circuit.
- To learn to analyze the PN junction behavior at the circuit level and its role in the operation of diodes and active device.

Course Outcomes:
After completing the course, the students should be able to:

1. Analyze PN junctions in semiconductor devices under various conditions.
2. Design and analyze simple rectifiers and voltage regulators using diodes.
3. Describe the behavior of special purpose diodes.
4. Design and analyze simple BJT and MOSFET circuits.

Unit - I
Junction Diode Characteristics: Open circuited p-n junction, Biased p-n junction, p-n junction diode and current components in PN junction Diode, diode equation, Diode capacitance, and energy band diagram of PN junction Diode. V-I Characteristics of PN junction and Zener Diode, Zener diode as Voltage Regulator. Switching Devices: LED, Varactor diode, Tunnel Diode, UJT-characteristics. Photo diode, SCR, Diac, Triac.
Rectifiers: Half wave rectifier, full wave rectifier, bridge rectifier
Filters: Capacitor filter, Inductor filter, LC filter.

Unit - II
BJT: Junction transistor, transistor current components, transistor configurations, transistor as a switch, and characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, early effect, punch through/ reach through.
FET: FET types, construction, operation, characteristics, parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

Unit - III
Transistor Biasing and Thermal Stabilization: Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self-bias, Stabilization concepts, Stability factors, Compensation, Thermal runaway, heat sinks, Thermal stability

Unit - IV

Small Signal Low Frequency Transistor Amplifier Models: BJT: Two port network, Transistor hybrid model, determination of h-parameters, generalized analysis of transistor amplifier model, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers, FET small signal model and their analysis of different configuration. High Frequency Analysis.

Suggested Readings

1. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Fourth Edition 2015.
2. Electronic Devices and Circuits – Salivahanan, N Suresh Kumar, Tata Mc-Graw Hill, Fifth Edition 2022.
3. Microelectronic Circuits – Sedra and Smith, Oxford Series.
4. Introduction to PSpice Using OrCAD for Circuits and Electronics – M. H. Rashid, Pearson.
5. Electronic Devices and Circuit Theory – Robert L. Boylestad, Pearson

List of Experiments (Hardware on Breadboard / Software using NI Multisim)

1. Obtain I-V characteristics of Silicon/Germanium based PN Junction Diode and extract diode parameters such as ideality factor, richardson's constant, and leakage components.
2. Obtain I-V characteristics of Zener Diode and observed Line and Load Regulation.
3. Obtain I-V characteristics of Varactor Diode.
4. Obtain I-V characteristics of Tunnel Diode.
5. Obtain I-V characteristics of SCR.
6. Obtain I-V characteristics of Diac and Triac.
7. Obtain the UJT Characteristics.
8. Obtain the Input and Output characteristics of BJT in CB configuration.
9. Obtain the Input and Output characteristics of BJT in CE configuration.
10. Perform parameter extraction of BJT using S – parameters (based on VNA)
11. Obtain the Input and Output Characteristics of JFET.
12. Obtain the Input and Output Characteristics of MOSFET.
13. Obtain the Frequency response of CE amplifier (based on Spectrum Analyzer).
14. Obtain the Frequency response of Emitter Follower (CC amplifier - based on Spectrum Analyzer).

(Note: Course instructor may add/update new experiments in addition to the above suggested practical exercises.)

Network Analysis and Synthesis (DSC - 8)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Network Analysis and Synthesis	4	3	0	1	Introduction to Electrical and Electronics Engineering

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To introduce fundamentals of Engineering Circuit Analysis and Design.
- To make the students capable of analyzing any given electrical network.
- To make the students learn how to synthesize an electrical network from a given impedance/admittance function.

Course Outcomes:

After completing the course, the students should be able to:

1. Apply the knowledge of basic circuital law and simplify the network using reduction techniques.
2. Analyze the circuit using Kirchhoff's law and Network simplification theorems.
3. Infer and evaluate transient response, Steady state response, network functions.
4. Obtain the maximum power transfer to the load, and analyse the series resonant and parallel resonant circuit.
5. Evaluate two-port network parameters, design attenuators and equalizers

Unit - I

Review of network elements: Linear versus nonlinear, time-variant and time invariant, passive verses active, causal and non-anticipated, stable and unstable networks, Network theorems: superposition, Thevenin and Norton's, maximum power transfer, Star-Delta transformation.

Unit - II

Network graph theory, notations and definitions, incidence matrix, cut-sets and fundamental loops, fundamental cutsets matrix, Kirchoff voltage law, Kirchoff current law, interrelationship between matrices of a graph, Tellegen's theorem and its application

Unit - III

Analysis of linear time invariant networks, transform methods in circuit analysis, Laplace transform of common signals, concept of transformed impedance, network functions, poles and zeros, impulse response, step response, convolution.

Unit - IV

Two-port network parameters: driving point and transfer functions. conversion, various inter connections, analysis using various two port parameters.

State equations for networks. State variable analysis of circuits, formulation of state equations, solution of state equations. Transient Response of RC, RL, RLC Circuits to various excitation signals such as step, ramp, impulse and sinusoidal excitations using Laplace Transform. Steady state sinusoidal analysis.

Network synthesis, positive real functions, driving point synthesis (RC, RL, LC) Introduction to passive filter.

Suggested Readings

1. Network Analysis by M.E. Van Valkenburg, Pearson
2. Engineering Circuit analysis by Hyat Jr. and Kemmerly, McGraw Hill
3. Network Analysis and Synthesis by Franklin F. Kuo, Wiley
4. Introduction to Modern Network Synthesis by M. E. Valkenburg, Wiley

List of Experiments (Hardware on Breadboard / Software using NI Multisim)

1. Determine Z and Y Parameters of two – port network.
2. Determine ABCD parameters of two – port network.
3. Determine h – parameters of two – port network.
4. Determine time constant of RC circuit.
5. To verify RC/RL circuit as differentiator and integrator.
6. To study step response of series RC and RL circuit.
7. To study resonance in RLC circuit.
8. To determine equivalent parameters of parallel connections of two – port network.
9. To synthesize a network of a given network function and verify its response.
10. Study of step response of RC and RL Network.
11. Design a Low Pass Filter (Butterworth Approximation) and study its frequency response.
12. Design a Low Pass Filter (Chebyshev Approximation) and study its frequency response.

(Note: Course instructor may add/update new experiments in addition to the above suggested practical exercises.)

Digital Electronics – I (DSC - 9)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Digital Electronics-I	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- Understand digital logic fundamentals, Boolean algebra, and circuit design.
- Analyze combinational and sequential circuits.
- Develop practical skills through hands-on projects.

Course Outcomes:

After completing the course, the students should be able to:

1. Interpret, convert and represent different number systems.
2. Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplification.
3. Design and analyze combinational and sequential logic circuits.

Unit - I

Boolean algebra, Switching Function, minimization of switching function: Karnaugh map method and Tabulation Method don't care terms and applications with respect to code converters and Digital Comparators, etc.

Introduction to Number Systems and Codes: Switching properties of Diodes, BJT and FET, Logic gates, DTL, TTL, ECL, I2L, CMOS Gates and their parameters and comparisons, Applications of switching transistors in bistable, monostable, astable and Schmitt trigger circuits.

Unit - II

Gated Flip Flops, Master Slave Flip Flop, Ripple and Parallel Counter, Up-Down Counter, Shift Registers and Ring Counter, designing the combinational circuits of the counters through Excitation Table.

Introduction to the circuits for Arithmetic Unit: Serial and parallel Binary Adders, 2's compliment and principle of subtraction, Carry-Look Ahead Adder, and BCD adder: Principles of multiplication, division in ALU.

Unit - III

Semiconductor memories: ROM, PROM, EPROM, EEPROM, Bipolar RAM, static and dynamic RAM. Encoder and Decoder, Demultiplexer, multiplexer, Designing combinational circuits with multiplexer, ROM, PAL and PLA.

Unit - IV

Analog-to-Digital conversion: dual slope integration method and voltage to frequency conversion, principal of DVM., counter type, successive approximation type, Flash ADC, D-A converter: weighted resistors type, R2R ladder type.

Suggested Readings

1. Modern Digital Electronics by R. P. Jain (TMH)
2. Digital Principles and Application by Malvino and Leach (TMH)
3. Digital Design by M. Mano and Michael D. Ciletti (Pearson)
4. Introduction to System Design Using Integrated Circuits by B. S. Sonde (New Age International)

List of Experiments (Hardware on Breadboard / Software using NI Multisim)

1. Characterization of Logic Family (Use Universal NAND Gates) on Breadboard.
    a. Find out logic threshold values and noise margins.
    b. Propagation delay time measurement of inverter using ring oscillator with 3,5,7,9, and 11 inverter elements.
2. Design, Implement, and verify a: Half – Adder, and Full Adder.
3. Design, Implement, and verify a: Half – Subtractor, and Full Subtractor.
4. Design, Implement, and verify a 2 – bit binary comparator using basic gates.
5. Design, Implement, and verify a 3 × 8 decoder and 8 × 1 multiplexer using basic gates.
6. Design, Implement, and verify a 4 – bit binary counter and a decimal counter using basic gates. Demonstrate output on LEDs.
7. Design, Implement, and verify all the Flip Flops using basic gates.
8. Design, Implement, and verify the Schmitt Trigger circuit.

(Note: Course instructor may add/update new experiments in addition to the above suggested practical exercises.)

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Elective (DSE) Courses for B. Tech. (ECE) – Semester 3

Computational Methods (DSE – 1)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Computational Methods	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To familiarize different numerical methods to solve engineering problems.
- To write computer programs and use tool boxes in the software packages.
- To select a specific numerical method to solve practical problems.

Course Outcomes:
After completing the course, the students should be able to:

1. To understand numerical methods to find roots of functions and first order unconstrained minimization of functions.
2. To introduce concept of interpolation methods and numerical integration.
3. To understand numerical methods to solve systems of algebraic equations and curve fitting by splines.
4. To understand numerical methods for the solution of Ordinary and partial differential equations.

Unit - I
Taylor Series, Rolle's Theorem and Mean Value Theorem, Approximations and Errors in numerical computations, Data representation and computer arithmetic, Loss of significance in computation Location of roots of equation: Bisection method (convergence analysis and implementation), Newton Method (convergence analysis and implementation), Secant Method (convergence analysis and implementation). Unconstrained one variable function minimization by Fibonacci search, Golden Section Search and Newton's method. Multivariate function minimization by the method of steepest descent, Nelder- Mead Algorithm.

Unit - II
Interpolation: Assumptions for interpolation, errors in polynomial interpolation, Finite differences, Gregory-Newton's Forward Interpolation, Gregory-Newton's backward Interpolation, Lagrange's Interpolation, Newton's divided difference interpolation Numerical Integration: Definite Integral, Newton Cote's Quadrature formula, Trapezoidal Rule, Simpson's one-third rule, simpson's three-eight rule, Errors in quadrature formulae, Romberg's Algorithm, Gaussian Quadrature formula.

Unit - III

System of Linear Algebraic Equations: Existence of solution, Gauss elimination method and its computational effort, concept of Pivoting, Gauss Jordan method and its computational effort, Triangular Matrix factorization methods: Dolittle algorithm, Crout's Algorithm, Cholesky method, Eigen value problem: Power method Approximation by Spline Function: First-Degree and second-degree Splines, Natural Cubic Splines, B Splines, Interpolation and Approximation.

Unit - IV

Numerical solution of ordinary Differential Equations: Picard's method, Taylor series method, Euler's and Runge-Kutta's methods, Predictor-corrector methods: Euler's method, Adams Bashforth method, Milne's method.

Numerical Solution of Partial Differential equations: Parabolic, Hyperbolic, and elliptic equations.

Suggested Readings

1. E. Ward Cheney and David R. Kincaid, "Numerical Mathematics and Computing," Cengage.
2. R. L Burden and J. D. Faires, "Numerical Analysis," Cengage.
3. S. D. Conte and C. de Boor, "Elementary Numerical Analysis: An Algorithmic Approach," McGraw Hill.
4. E. Balagurusamy, "Numerical Methods," McGraw Hill.
5. Laurence V. ausett, "Applied Numerical Analysis using MATLAB," Pearson

List of Experiments (Software Based)

1. To implement Bisection method for finding roots of a given quadratic equation.
2. To implement Regula Falsi method for finding roots of a given quadratic equation.
3. To implement Secant method for finding roots of a given quadratic equation.
4. To implement Newton's method for finding roots of a given quadratic equation.
5. To implement Newton's method for solving a system of linear equations.
6. To implement Gauss Thomas method for tri-diagonal system.
7. To implement Jacobi method for solving a system of linear equations.
8. To implement Gauss-Seidel method for solving a system of linear equations.
9. To implement Linear Spline Interpolation.
10. To implement Cubic Spline Interpolation.
11. To approximate finite integrals using Romberg Integration.
12. To approximate finite integrals using Gaussian Quadrature.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

PCB based System Design (DSE – 1)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
PCB based System Design	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:
The main aim of this course is to make students learn different PCBs for analog, digital, biomedical, wearable electronics, high frequency and power electronics applications. They will learn the electronic manufacturing and packaging aspects with the electrical, mechanical and thermal design considerations required for optimize designing of PCB.

Course Outcomes:
After completing the course, the students should be able to:

1. Learn electronic manufacturing and packaging aspect.
2. Understand electronic packaging, hierarchy, and methods for various environments.
3. Understand the material requirement and optimization process of PCB Design.
4. Design and develop PCB with MSI circuits for different applications.

Unit - I
PCB Fundamentals: PCB Advantages, components of PCB, Electronic components, IC's, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.

Unit - II
Technology OF PCB: Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper clad laminates materials of copper clad laminates, properties of laminates (electrical and physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.

Unit - III
Overview of Electronic Systems Packaging: Definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products, Definition of PWB, Basics of Semiconductor and Process flowchart, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution; Chip connection choices, Wire bonding, TAB and flip chip,

Schematic and Layout Design: Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.

Unit - IV
PCB design for EMC compliance: Return path discontinuities-mixed signal PCB layout, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Thermal management Experiments Design and development of PCBs using different simulator tools and prototyping.

Suggested Readings

1. Jon Varteresian, “Fabricating Printed Circuit Boards,” Newnes.
2. R. S. Khandpur, “Printed Circuit Board Design, Fabrication Assembly and Testing,” McGraw.
3. K. Mitzner, “Complete PCB Design Using OrCad Capture and Layout,” Elsevier.
4. Walter C. Bosshart, “Making Printed Circuit Boards,” J. Axelson, McGraw.
5. Xing-Chang Wei, “Modeling and Design of Electromagnetic Compatibility for High-Speed Printer Circuit Boards and Packaging,” CRC Press.

List of Experiments (Based on Hardware/ Simulation)

The experiments in this DSE will involve the layout designing of different circuits already analyzed by students during 1st Year on CAD tools. The GDS file of the layout will be used for actual fabrication of the PCB through PCB Machine and/or Toner Transfer technique.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Core (DSC) Courses for B. Tech. (ECE) – Semester 4

Signals and Systems (DSC - 10)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Signals and Systems	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To describe various signals and systems mathematically and understand how to perform mathematical operations on them.
- Also familiar with commonly used signals such as the unit step, ramp, and impulse function, sinusoidal signals, complex exponentials and their operations.
- Analysis using Fourier series and Fourier transform for a given signal.

Course Outcomes:
After completing the course, the students should be able to:

1. Understand and analyse the mathematical modeling of various signals and systems.
2. Analyse continuous and discrete time linear time invariant systems
3. Evaluate and analyse various signals in terms of Fourier and Laplace transform.
4. Evaluate and analyse the reconstruction of signals.

Unit - I
Introduction: Basic concepts and definitions of continuous and discrete time Signals and their classification, continuous and discrete time system and their properties, elementary Signals. Linear time invariant systems response for continuous time systems and discrete time systems. Properties of continuous and discrete LTI systems. System representation through differential equations and difference equations.

Unit - II
Introduction to Fourier Transform Analysis: continuous and discrete time Fourier series and its properties, Fourier Transform for continuous and discrete time signals/system. Concept of bandwidth estimation for signal and system. Magnitude and phase spectra of continuous and discrete time signal, response of LTI system using Fourier transform. Application of Fourier transform as linear filtering.

Unit - III
The Laplace Transform. The Region of Convergence for Laplace Transforms. The Inverse Laplace Transform. Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot. Properties of the Laplace Transform. Some Laplace Transform Pairs. Analysis and Characterization of LTI Systems Using the Laplace Transform. System Function Algebra and Block Diagram Representations. The Unilateral Laplace Transform.

Z-Transform: Basic principles of z-transform, z-transform definition, Relationship between z-transform and Fourier transform, Region of Convergence, Properties of ROC, Properties of z-transform, Poles and Zeros, Inverse z-transform using Contour integration, Residue Theorem, Power Series expansion and Partial fraction expansion.

Unit - IV

Sampling: Representation of continuous time signals by its sample – Types of sampling, sampling theorem, aliasing, decimation, interpolation. Reconstruction of a Signal from its samples. Mathematical Background: Representation of signals using ortho-normal basis functions. Power and Energy spectral density. Correlation functions. Hilbert Transform and its properties. Pre-envelope and Complex Envelope. Band pass signals and Band pass systems.

Suggested Readings

1. Signals and Systems by Alan V. Oppenheim (Pearson Education)
2. Signals and Systems by Simon Haykin (John Wiley and Sons)
3. Linear Systems and Signals by B. P. Lathi (Oxford Publication)
4. Fundamentals of Signal and Systems using the Web and MATLAB by Kamen (Pearson)
5. Schaum's Outline of Signals and Systems by Hwei P. Hsu (TMH)

List of Experiments (Software using MATLAB)

1. Generation of Continuous Time and Discrete Time signals.
2. Implementation of Fourier Transform and Inverse Fourier Transform.
3. Implementation of Laplace Transform and Inverse Laplace Transform.
4. Implementation of Z – Transform and Inverse Z - Transform.
5. Implementation of Digital Filter (IIR and FIR Filters)

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Electromagnetic Theory (DSC - 11)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electromagnetic Theory	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P – 02

Course Objectives:

- To understand Maxwell's Equation and apply to the basic electromagnetic problem.
- To interpret the given problem, and solve it using Maxwell's equations.
- To analyze boundary conditions, and understand the field at the interface of two different media.
- To analyze time varying electric and magnetic fields, wave propagation in different media.
- To understand transmission line fundamentals and apply them to the basic problem.
- To understand the fundamentals of electromagnetic theory and transmission lines

Course Outcomes:
After completing the course, the students should be able to:

1. Recognize and classify the basic Electrostatic theorems and laws and to derive them.
2. Discuss the behavior of Electric fields in matter and Polarization concepts.
3. Classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
4. Summarize the concepts of electrodynamics and to derive and discuss the Maxwell's equations.
5. Students are expected to be familiar with Electromagnetic wave propagation and wave polarization.

Unit - I
Introduction to Coordinate System - Cartesian, Cylindrical and Spherical Coordinates, Electrostatic Fields: Electric field, Gauss's Law and its Applications, Electric field due to continuous charge distributions, Electric potential, an electric Dipole and flux lines, Energy density in electrostatic fields, Dielectric Materials, Polarization in Dielectrics, Dielectric Constant, Linear, Homogeneous and Isotropic Dielectric, Boundary Conditions. Poisson's Equation and Laplace's Equation: Poisson's and Laplace's equation, Uniqueness Theorem, Examples of Laplace's Equation in Cartesian, Cylindrical and Spherical Coordinates. Magnetostatics: BiotSavart's law, Ampere's Circuital Law, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials, forces due to magnetic fields, Magnetic Dipole, magnetization in materials and Magnetic Boundary Conditions, Magnetic Energy.

Unit - II
Maxwell's Equations: Faraday's laws, Transformer and motional E.M.F, displacement current, Maxwell Equation in differential and integral form, constitutive relations and Boundary Conditions. Electromagnetic Wave Propagation: the wave equation, Uniform Plane Wave, Wave Polarisation, Wave propagation in Dielectrics, Poynting's theorem, Propagation in Good Conductors, Skin Effect, Reflection of uniform Plane Waves at normal incidence, Plane Wave reflection at Oblique Incidence, Wave propagation in dispersive media, concept of phase velocity and group velocity.

Unit - III
Transmission Lines: Typical Transmission lines- Co-axial, Two Wire, Microstrip, Coplanar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines, lowloss, lossless line, Distortionless line, Input Impedance, Standing Wave Ratio, Power. and lossy lines, Shorted Line, Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications.

Unit - IV

Waveguides and Antennas: Rectangular waveguide, Field Equations for TM and TE modes, Wave Propagation in Waveguide, Propagation Characteristics, Power Transmission and Attenuation, Waveguide Current and Excitation, Rectangular Cavity Resonators, Radiation of Electromagnetic Waves and Retarded Potentials, Hertzian dipole, Types of antenna- yagi, microstrip, parabolic antenna's, Antenna characteristics.

Suggested Readings

1. Matthew N.O. Sadiku, "Principles of electromagnetics" 4th edition, Oxford university Press, 2014.
2. Hayt Jr, William H., John A. Buck, and M. Jaleel Akhtar, "Engineering Electromagnetics| (SIE)", McGraw-Hill Education, 2020.
3. Karl E. Longren, Sava V. Savov, Randy J. Jost., "Fundamentals of Electromagnetics with MATLAB", PHI (For MATLAB experiments)
4. D. C. Cheng, "Field and Wave Electromagnetics," Pearson Education (2001)
5. J. A. Edminster, "Electromagnetics," Schaum Series, Tata McGraw Hill (2006)
6. N. Narayanrao, "Elements of Engineering Electromagnetics," Pearson Education (2006)

List of Experiments (Hardware Based)

1. To study electric field pattern between two circular electrodes.
2. To study the electric field between parallel conductors.
3. To study Electric Field and Potential Inside the Parallel Plate Capacitor
4. To study Capacitance and Inductance of Transmission Lines.
5. To study Magnetic Field Outside a Straight Conductor.
6. To study Magnetic Field of Coils.
7. To study Magnetic Inductions.
8. Hertz's Experiment to demonstrate the production and reception of radio waves
9. Wireless RF Transmitter and Receiver
10. Simple AM Transmitter and Receiver.
11. Using a Slotted Waveguide study Standing Waves, Travelling Waves and find SWR for each case.
12. Given a Slotted Waveguide connected with source and voltmeter. Find practical Maximas and Minima under following load conditions (a) Short Circuit, and (b) Matched Load.

List of Experiments (Software Based using MATLAB)

1. WAP to find gradient of a scalar field.
2. WAP to find divergence of a vector field.
3. WAP to find curl of a vector field.
4. WAP to:
    a. Transform cylindrical coordinates to cartesian coordinates.
    b. Transform spherical coordinates to cartesian coordinates.
    c. Transform cartesian coordinates to cylindrical coordinates.
    d. Transform cartesian coordinates to spherical coordinates.
5. WAP to represent electric field lines due to a point charge at origin.
6. WAP to plot equipotential contours and electric field due to dipole.
7. WAP to plot magnetic flux density due to current carrying wire.
8. WAP to show that a given potential distribution satisfied Possion's Equation. Plot graphs of charge and electric potential distributions.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Linear Integrated Circuits (DSC – 12)

(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Linear Integrated Circuits	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non - linear applications of operational amplifiers.
- To introduce the theory and applications of analog multipliers and PLL.
- To teach the theory of ADC and DAC.
- To introduce the concepts of waveform generation and introduce some special function ICs.
- To understand and implement the working of basic digital circuits.

Course Outcomes:

After completing the course, the students should be able to:

1. Understand the internal operation of Op-Amp and its specifications.
2. Analyze and design linear applications like adder, subs tractor, instrumentation amplifier and etc. using Op-Amp.
3. Classify various active filter configurations based on frequency response and construct using 741 OpAmp.
4. Operate 555 timers in different modes like bistable, monostable and astable operations and study their applications.
5. Determine the lock range and capture range of PLL and use in various applications of communications.

Unit - I

Operational Amplifier: The ideal Op Amp, Building blocks of analog ICs: current mirrors and repeaters, current and voltage sources, differential amplifiers, input stages, active load, gain stages, output stages, level shifters, non ideal parameters, Monolithic IC operational amplifiers, specifications, slew rate and methods of improving slew rate.

Unit - II

Linear applications of IC op-amps: Inverting and non-inverting amplifier configurations, integrators, differentiators, summers, effect of infinite GBP, stability consideration, active and passive compensation of op amp. Non-Linear applications of IC op-amps: Log/ antilog modules, Precision Rectifier, Op-amp as comparator, Schmitt Trigger, Square and Triangular wave generator, mono stable and astable multivibrators.

Unit - III

Analog filter design: Basics second order functions, op-amp RC and active filter design, immittance converters and inverters, generalized impedance converter, inductance simulation, Sinusoidal oscillators, amplitude stabilization and control. Operational Transconductance Amplifier (OTA), Basic building blocks using OTA, Application examples.

Unit - IV

Analog Multiplier and its applications: Gilbert multiplier cell 2-quadrant and 4-quadrant operations, IC analog multiplier AD534, modulation, demodulation and frequency changing, voltage-controlled filters and oscillators

IC timer and phase locked loop: the IC 555 timer, operational modes, time delay, astable and monostable operations, voltage-controlled oscillators, IC PLL: basic PLL principle, three modes of operation, PLL as AM detector, FM detector, frequency synthesis, FM demodulator, PLL motor speed control and voltage to frequency converter.

Suggested Readings

1. Applications and Design with Analog Integrated Circuits by J. Michel Jacob (PHI)
2. Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco (TMH).
3. Analysis and Design of Analog Integrated Circuits by Paul R. Gray and Robert G. Meyer (Wiley).
4. Microelectronic Circuits: Analysis and Design by M. H. Rashid (CENGAGE)
5. OP-Amps and Linear Integrated Circuits by R. A. Gayakwad (Pearson)

List of Experiments (Hardware and Software using NI Multisim)

1. To study op-amp characteristics: CMRR and Slew rate.
2. To design an amplifier of given gain for an inverting amplifier and observed its frequency response.
3. To design an amplifier of given gain for a non - inverting amplifier and observed its frequency response.
4. To design an integrator using op-amp for a given specification and stud its frequency response.
5. To design a differentiator using op-amp for a given specification and study its frequency response.
6. To study IC555 as an astable multivibrator.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Elective (DSE) Courses for B. Tech. (ECE) – Semester 4

Interfacing Electronics (DSE – 2)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Interfacing Electronics	4	2	0	2	NIL

Course Hours: L – 02, T – 00, P - 04

Course Objectives:
The objective of this course is to familiarize the students in Embedded System Design using Arduino and Raspberry pi.

Course Outcomes:
After completing the course, the students should be able to:
1. Understand how the Arduino platform works in terms of the physical board and libraries.
2. Understand the working of Raspberry Pi, its features and how various components can be used with Pi.
3. Program the development boards using C and use I/O pins for interfacing.

Unit - I
Embedded System design: Basics. Introduction to embedded systems, Components of embedded system. Advantages and applications of embedded systems, Examples of real time embedded systems and how they are manufactured industry ready, Different Microcontroller Architectures (CISC, RISC, ARISC), Internal Resources and Hardware Chips in Details, History of AVR Microcontrollers and Features, Memory Architectures (RAM/ROM).

Unit - II
Learning Arduino Platform: Introduction to ARDUINO, ARDUINO History and Family, General Programming and Hardware Interfacings with Arduino, The basic sensors and actuators using Arduino, Controlling embedded system based devices using Arduino.

Unit - III
Getting Started with Raspberry Pi: Basic functionality of the Raspberry Pi board and its Processor, setting and configuring the board, differentiating Raspberry Pi from other platform like arduino, begal, asus thinker etc., Overclocking, Component overview.

Unit - IV
Programming the Raspberry Pi: Introducing to Python programming language: Python Programming Environment, Python Expressions, Strings, Functions, Function Arguments, Lists, List Methods, Control Flow, Numpy, PIP (Python Installation Package) and customized libraries. Communication facilities on raspberry Pi (I2C, SPI, UART), working with RPil. GPIO library, Interfacing of Sensors and Actuators.

Suggested Readings

1. M. Margolid, "Arduino Cookbook: Recipes to begin, expand, and enhance your projects," O'Reilly Media.
2. A. N. Sloss, "ARM System Developer's Guide – Designing and Optimizing System Software," Elsevier.
3. Mark Lutz, "Learning Python," O'Reilly Media.
4. The Official Raspberry Pi Projects Book: https://www.raspberrypi.org/magpi-issues/Projects_Book_v1.pdf
5. Raspberry Pi Assembly Language RASPBIAN Beginners, 3rd Edition, CreateSpace Independent Publishing Platform.

List of Experiments (Based on Hardware/ Simulation)

1. Connect an LED to GPIO pin 24 and a Switch to GPIO 25 and control the LED with the switch. The state of LED should toggle with every press of the switch.
2. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
3. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
4. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
5. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
6. Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.
7. Create an application that has three LEDs (Red, Green and white). The LEDs should follow the cycle (All Off, Red On, Green On, White On) for each clap (use sound sensor).
8. Write a program on Arduino/Raspberry Pi to upload/retrieve temperature and humidity data using ThingSpeak cloud.
9. Write a program on Arduino/Raspberry Pi to publish/subscribe temperature data using MQTT broker.
10. To install MySQL database on Raspberry Pi and perform basic SQL queries.
11. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
12. Create a web application for the above applications wherever possible with functionalities to get input and send output

In addition to above, course instructor will assign various projects to a group of students based on interfacing various types of sensors and actuators for a particular problem statement. The emphasis will be towards maximizing the practical component.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Modeling Electronic Circuits (DSE – 2)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Modeling Electronic Circuits	4	2	0	2	NIL

Course Hours: L – 02, T – 00, P - 04

Course Objectives:
The objective of this course is to familiarize the students in SPICE modeling of various electronic circuits.

Course Outcomes:
After completing the course, the students should be able to:
1. Model electronic devices and circuits using SPICE modeling.
2. Understand the fundamentals of SPICE simulation and modeling.
3. Perform various types of circuit analysis using SPICE.
4. Develop accurate SPICE models for semiconductor devices.
5. Apply SPICE simulation techniques to real-world circuit design and optimization.

Unit - I
Introduction to SPICE, Description of SPICE, Types of SPICE (Introduction to LTspice, PSice, and other variants), File Types, SPICE Platforms, Limitations. Writing SPICE circuit files – SPICE Directives (dot commands: .end, .FUNC, .NET, .OPTIONS, etc.).

Unit - II
DC Operation and Circuit Analysis: Modeling of elements, operating temperature, independent DC sources, dependent sources, DC Output Variables, Passive Devices, Types of Output (.PRINT, .PLOT, .PROBE, .WIDTH) statements and significances, Tyes of DC Analysis (.OP, .TF, .DC, .PARAM – parameter sweep) commands and their uses, and DC Sweep.
AC Circuit Analysis: AC Output Variables, Independent AC Sources, AC Analysis, Magnetic Elements, group delay, phase angle of voltage and current, Transfer Function Analysis.
Advanced Components and Models: Diodes, Transistors (BJT and MOSFET), Operational Amplifiers, Behavioral Modeling, Statistical Analysis for Circuit Reliability (Monte Carlo Analysis)

Unit - III
Transient Analysis: Capacitors and Inductors, Modeling of Transient Sources (Exponential Source, Pulse Source, Piecewise Linear Source, Sinusoidal Source), Independent Voltage Source, Independent Current Source, Transient Response (.IC, .TRAN, .WAVE) commands and their uses.
Transient Circuits and Laplace Transforms, Transfer Functions, Fourier Analysis (.FOUR)
Noise Analysis: total RMS noise at output node, equivalent noise at the input node (.NOISE)
Device Modeling Fundamentals: SPICE Model Parameters, BJT Model (Ebers – Moll Model, Gummel – Poon Model), Parameter Extraction and Model Fitting, MOSFET Modeling (Level 1,2, and 3, BSIM3, BSIM4, Parameter Extraction), and other semiconductor devices, Temperature Effects.

Unit - IV (12 Hours)
Developing simple circuit files for CE Amplifier, Passive Linear/ Non – Linear Circuits, Circuits with R, L, C Components, Diodes).
Developing Component Models, sub – circuits in SPICE (,model, .subckt, .lib, .inc, .ends directives). Using datasheet to develop component models – (BJTs, MOSFETs).
Subcircuit Modeling and Hierarchical Design, Mixed Signal Simulation (Co – Simulation of Analog and Digital Circuits), RF and High Frequency Simulation (S – Parameter Analysis, RF Amplifier and Oscillator Design).

Suggested Readings

1. Paul Tobin, "PSpice for Circuit Theory and Electronic Devices," Morgan and Claypool.
2. Muhammad H. Rashin, "Introduction for PSPICE Using OrCAD for Circuits and Electronics," Prentice-Hall.
3. Paul W. Tuinenga, "SPICE: A Guide to Circuit Simulation and Analysis using PSPICE," Pearson.
4. Gordon W. Roberts, Adel S. Sedra, "SPICE," Oxford.
5. Dennis Fitzpatrick, "Analog Design and Simulation using OrCAD Capture and PSPICE," Newnes.

List of Experiments (Based on Simulation)

1. Introduction to SPIC interface.
2. Simulating Basic Circuits: Ohm's Law, Voltage Dividers, RC Circuits
3. Simulation of Diode and Transistor Characteristics
4. AC Sweep Analysis of Amplifiers
5. Transient Analysis of Switching Circuits
6. BJT Model Parameter Extraction and Simulation
7. MOSFET Characterization and Model Fitting
8. Simulation of JFET and MESGET Circuits
9. Subcircuit Creation and Simulation
10. Noise Analysis of Amplifiers
11. Mixed – Signals Circuit Simulation
12. High – Frequency Circuit Design and Simulation

The experiments in this DSE will involve the modeling of different circuits already analyzed by students during 1st Year on CAD tools.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

List of Discipline Specific Elective (DSE)/ Generic Elective (GE) courses offered for Minors/ Specializations by the Department in Second Year

1. **Minor in ECE (Offered only to CSE and EE)**
   a) DSE - 1/ GE-3: Fundamentals to Analog Electronics
   b) DSE - 2/GE-4: Introduction to Signals and Systems

2. **Minor/ Specialization in Telecommunication Networks (Offered to ECE, CSE, and EE)**
   a) DSE - 1/ GE-3: Introduction to Analog Communication
   b) DSE - 2/ GE-4: Fundamentals of Digital Communication

3. **Minor/ Specialization in VLSI Technology and System Design (Offered to ECE, CSE, and EE)**
   a) DSE - 1/ GE-3: VLSI Technology and Design
   b) DSE - 2/ GE-4: Microelectronics Design

4. **Minor/ Specialization in IoT System Design (Offered to ECE, CSE, and EE)**
   a) DSE - 1/ GE-3: Introduction to IoT
   b) DSE - 2/GE-4: Introduction to IoT System Design

5. **Minor/ Specialization in Computer Vision (Offered to ECE, CSE, and EE)**
   a) DSE - 1/ GE-3: Fundamentals of Image Processing
   b) DSE - 1/ GE-4: Image Filtering and Restoration

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Generic Elective (GE) courses offered for Minors/ Specializations by the Department in Semester 3

Fundamentals of Analog Electronics (DSE – 1/ GE – 3)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Analog Electronics	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To introduce components such as diodes, BJTs and FETs.
- To know the applications of components.
- To give Understand of various types of amplifier circuits.

Course Outcomes:
After completing the course, the students should be able to:

1. Know the characteristics of various components.
2. Understand the utilization of components.
3. Design and analyse small signal amplifier circuits.

Unit - I
Introduction to Switching Devices (basic construction and IV characteristics): PN Junction Diode, Zener Diode, LED, Varactor diode, Tunnel Diode, UJT-characteristics. Photo diode, SCR, Diac, Triac
Diode Applications: Rectifiers and Filters. Linear wave shaping - High Pass and Low Pass RC circuits. RC network as differentiator and integrator. Non-linear wave shaping: Diode clippers, clipping at two independent levels, Transfer characteristics of clippers, Clamping operation, clamping circuits using diode with different inputs, Clamping circuit theorem.

Unit - II
BJT: Working, Construction, Biasing and Techniques, Input and Output Characteristics of CE, CC, CB configuration, Concept of Thermal Runaway, Base Width Modulation, and Early Voltage, Application as Switch, CE Amplifier (Transformer, RC, and Direct Coupled), Darlington Pair, Introduction to Small Signal Analysis.

Unit - III
MOSFET: MOSFET types (depletion and enhancement mode), construction, operation, characteristics, Introduction to Small Signal Analysis.

Power Amplifiers: Various classes of Power amplifiers: Class A, Class B, Class AB, Class C and Class D, power efficiency and harmonic distortion.

Unit - IV

Oscillators: Oscillator principle, condition for oscillations (barkhausen's criteria), types of oscillators, RC-phase shift and Wein bridge oscillators with BJT and their analysis, Generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators with BJT and their analysis.

Reference Books

1. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Fourth Edition 2015.
2. Electronic Devices and Circuits - Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, Fourth Edition 2016.
3. Microelectronic Circuits – Sedra and Smith, Oxford Series
4. Introduction to PSpice Using OrCAD for Circuits and Electronics – M. H. Rashida, Pearson.
5. Electronic Devices and Circuit Theory – Robert L. Boylestad, Pearson

List of Experiments (Hardware on Breadboard / Software using NI Multisim)

1. Design clipping circuits for both positive and negative reference voltages
2. Design clamping circuits for both positive and negative reference voltages
3. Obtain the response of high pass and low pass RC circuit for various inputs
4. To study different biasing techniques of BJT.
5. Frequency Response of CE BJT Amplifier.
6. Frequency Response of Common Source FET Amplifier
7. Design and observe the working of RC-phase shift Oscillator.
8. Design and observe the working of Colpitts Oscillator.
9. Design and observe the working of Wein Bridge Oscillator.
10. Design and observe the working of Hartley and Colpitt's Oscillator.
11. Class A, Class B, Class AB Power amplifier

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Introduction to Analog Communication (DSE – 1/ GE – 3)

(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to Analog Communication	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To impart understanding of the concepts of analog communication systems.
- To impart understanding of various modulation and demodulation techniques of analog communication.
- To impart understanding of transmitters and receivers in analog communication.
- To impart understanding of the causes of noise and noise performance of analog communication.

Course Outcomes:

After completing the course, the students should be able to:

1. To understand the concepts of analog communication systems.
2. To understand various modulation and demodulation techniques of analog communication.
3. To understand transmitters and receivers in analog communication.
4. To understand the causes of noise and noise performance of analog communication.

Unit - I

Introduction to Communication systems, source of information, communication channels, base band pass band signals, representation of signals and systems, analog versus digital communication, applications of communications systems.

Unit - II

Linear modulation: Time and frequency domain expression of AM, DSB, SSB and VSB; generation of linearly modulated signals. Coherent demodulation and envelope detection. Angle modulation: Instantaneous frequency; phase and frequency modulation (PM and FM)

Unit - III

Multiplexing Techniques, radio transmitters and receivers, sampling theory (sample and hold circuits and their working, Nyquist Criteria, Bandwidth Requirements), Pulse Modulation Techniques - including PCM, PPM, PWM, DM, ADM, and its variants.

Unit - IV

Noise in Communication systems: Thermal noise, shot noise and white noise. Noise equivalent bandwidth, noise figure and noise temperature. Comparison of the noise performance of CW modulation schemes.

Suggested Readings

1. Communication System by Simon Haykin (John Wiley and Sons)
2. Communication Systems by Proakis (John Wiley and Sons)
3. Modern Analog and Digital Communication by B. P. Lathi (Oxford)
4. Electronic Communication Systems by Kennedy (TMH)
5. Principles of Communication System by Taub and Schilling (TMH)

List of Experiments (Hardware on Breadboard / Software using NI Multisim)

1. Study of different Sampling Techniques.
2. To study Amplitude Modulation - Modulation and Demodulation.
3. AM - DSB SC - Modulation and Demodulation.
4. Frequency Modulation - Modulation and Demodulation.
5. Sampling Theorem and its implementation.
6. Pulse Amplitude Modulation - Mod. and Demodulation.
7. To study PWM, PPM - Mod. and Demodulation.
8. To study TDM (Time Division Multiplexing).

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

VLSI Technology and Design (DSE – 1/ GE – 3)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
VLSI Technology and Design	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:
To provide an understanding of the manufacturing methods and their underlying scientific principles in the context of technologies used for VLSI chip fabrication.

Course Outcomes:
After completing the course, the students should be able to:

1. Analyze and explain the fundamental principles of VLSI Technology, including semiconductor physics, device characteristics, and fabrication processes.
2. Design and model basic VLSI devices and circuits, demonstrating proficiency in using industry-
3. standard software tools for simulation and analysis.
4. Evaluate the performance and limitations of different VLSI devices and technologies, and make informed decisions in selecting appropriate components for specific applications.
5. Apply their knowledge of VLSI technology to contribute effectively to the design and development of integrated circuits, taking into consideration the latest advancements and challenges in the field.

Unit - I
Review of Semiconductor Fundamentals and Device Physics: Introduction to semiconductor materials and crystal structures, Intrinsic and extrinsic semiconductors, doping, and carrier concentration, PN junctions and diode characteristics (including PIN), Bipolar Junction Transistors (BJTs) and Field-Effect Transistors (FETs) principles, MOSFET operation modes and characteristics.

Unit - II
VLSI Fabrication Processes: Overview of VLSI fabrication process flow; Photolithography and patterning techniques; Oxidation, diffusion, and ion implantation processes; Thin film deposition methods: CVD, PVD; Etching techniques: wet etching, dry etching, plasma etching; Interconnect technologies and back-end processing;

Unit - III
Device Modeling and Simulation: Introduction to device modeling and its significance, SPICE (Simulation Program Emphasis) fundamentals, MOSFET modeling: Level 1, Level 2, and Level 3 models, Capacitance and delay modelling, Process variations and statistical modelling,

Unit - IV
Advanced VLSI Technologies and Trends: Introduction to advanced CMOS technologies (TFET, SOI, FD-SOI, etc.), Low-power design techniques and considerations, Introduction to semiconductor memories: SRAM, DRAM, Flash, Emerging trends in VLSI.

Suggested Readings

1. N. Weste and D. Harris, "CMOS VLSI Design: A Circuits and Systems Perspective," Addison-Wesley, 2011.
2. J. Rabaey, A. Chandrakasan, and B. Nikolic, "Digital Integrated Circuits: A Design Perspective," Pearson, 2016.
3. E. J. Rymaszewski, "Advanced CMOS Process Technology," IEEE Press, 2005
4. S. M. Sze and K. K. Ng, "Physics of Semiconductor Devices," Wiley, 2006.
5. Y. Leblebici and M. Tan, "Fundamentals of Microelectronics," McGraw-Hill, 2013.
6. J. D. Meindl and S. F. Gong, "Conduction and Breakdown in Solid Dielectrics," IEEE Press, 1993.
7. C. Liu and S. M. Kang, "Introduction to Solid State Physics," Wiley, 2015

List of Experiments

(Will be based on open-source/ Proprietary EDA tools such as Silvaco's TCAD or Synopsys Sentaurus)

1. To carry out SPICE modeling/simulation of the PN junction diode.
2. To carry out SPICE modeling/simulation of the BJT.
3. To carry out SPICE modeling/simulation of the nMOS and pMOS transistors.
4. To perform virtual fabrication of PN junction diode and characterize it under different ambient temperatures.
5. To perform virtual fabrication of BJT and characterize it under different ambient temperatures.
6. To perform virtual fabrication of MOSFET and study the impact of ambient temperatures on Input and Output characteristics.
7. To perform virtual fabrication of CMOS technology and study its application towards low power applications.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Introduction to IoT (DSE – 1/ GE – 3)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to IoT	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To make students know the IoT ecosystem.
- To provide an understanding of the technologies and the standards relating to the Internet of Things.
- To develop skills on IoT technical planning.

Course Outcomes:
After completing the course, the students should be able to:

1. To understand the technology and standards relating to IoTs.
2. To understand the critical ecosystem required to mainstream IoTs.
3. To acquire skills on developing their own national and enterprise level technical strategies.

Unit - I
IoT and Web Technology: The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy and Trust, Device Level Energy Issues, IoT Related Standardization.

Unit - II
M2M to IoT – A Basic Perspective– Introduction, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit - III
IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Unit - IV
IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Internet of Things Privacy, Security and Governance Introduction, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, Data Aggregation for the IoT in Smart Cities.

Suggested Readings

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, “Internet of Things,” John Wiley and Sons.
2. Cuno Pfister, “Getting Started with the Internet of Things”, Shroff Publisher/Maker Media.
3. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications.
4. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/Maker Media Publishers.
5. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O’Reilly Publisher.

List of Experiments (Hardware – Raspberry Pi based/ Software based)

1. LED Control using R Pi.
2. Potentiometer and IR sensor interfacing with R Pi.
3. Controlling actuators using R Pi.
4. DHT11 sensor data to cloud.
5. IoT based air pollution control system.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Fundamentals of Image Processing (DSE – 1/ GE – 3)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Image Processing	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures

Course Outcomes:
After completing the course, the students should be able to:

1. Understand the basic principles of digital image processing and explain the core components of an image processing system.
2. Apply various image enhancement techniques to improve image quality and interpret the effects of different enhancement methods.
3. Implement image transformation and restoration techniques, and analyze their applications in noise reduction and image reconstruction.
4. Describe the principles of image compression, apply different compression algorithms, and evaluate their trade-offs between compression ratio and image quality.

Unit - I
Introduction to Image Processing: Introduction to digital image processing, image representation and models, human visual perception, image acquisition and sampling, color models and applications.

Unit - II
Image Enhancement: Histogram equalization, contrast stretching, spatial domain enhancement techniques (smoothing, sharpening), frequency domain enhancement (Fourier transform, filtering), adaptive and histogram specification.

Unit - III
Image Transformation and Restoration: Geometric transformations (scaling, rotation, translation), image interpolation methods, restoration models (degradation, noise), noise models (additive, multiplicative), image denoising techniques (spatial filters, median filters), image deblurring techniques.

Unit - IV
Image Compression: Lossless and lossy compression, entropy coding, Huffman coding, Run-Length Encoding (RLE), transform coding (Discrete Cosine Transform - DCT), JPEG image compression, evaluation metrics for compression.

Suggested Readings

1. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Prentice Hall, 3rd Ed.
2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.
3. S. Sridhar, Digital Image Processing, Oxford University Press.
4. R. C. Gonzalas, “Digital Image Processing using MATLAB,” McGraw Hill.

List of Experiments/ Practical (Based on MATLAB)

1. WAP to separate the 3 channels of an RGB Image.
2. WAP to demonstrate gamma correction of a Grayscale Image and observe the changes in the histogram plot.
3. WAP to demonstrate histogram equalization.
4. WAP to demonstrate image restoration of a blurred image.
5. WAP to demonstrate image segmentation based on edge discontinuity.
6. WAP to demonstrate image segmentation based on thresholding concept.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Department of Electronics and Communication Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Generic Elective (GE) courses offered for Minors/ Specializations by the Department in Semester 4

Introduction to Signals and Systems (DSE – 2/ GE – 4)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to Signals and Systems	4	3	0	1	NIL

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To describe various signals and systems mathematically and understand how to perform mathematical operations on them.
- Also familiar with commonly used signals such as the unit step, ramp, and impulse function, sinusoidal signals, complex exponentials and their operations.
- Analysis using Fourier transform for a given signal.

Course Outcomes:

After completing the course, the students should be able to:

1. Understand and analyse the mathematical modelling of various signals and systems.
2. Analyse continuous and discrete time linear time invariant systems
3. Evaluate and analyse various signals in terms of Fourier and Laplace transform.
4. Evaluate and analyse the reconstruction of signals.

Unit - I

Introduction: Basic concepts and definitions of continuous and discrete time Signals and their classification, continuous and discrete time system and their properties, elementary Signals. Linear time invariant systems response for continuous time systems and discrete time systems. Properties of continuous and discrete LTI systems. System representation through differential equations and difference equations.

Unit - II

Introduction to Fourier Transform Analysis: continuous and discrete time Fourier series and its properties, Fourier Transform for continuous and discrete time signals/system. Magnitude and phase spectra of continuous and discrete time signal, response of LTI system using Fourier transform.

Unit - III

The Laplace Transform. The Region of Convergence for Laplace Transforms. The Inverse Laplace Transform. Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot. Properties of the Laplace Transform. Some Laplace Transform Pairs. Analysis and Characterization of LTI Systems Using the Laplace Transform.

Unit - IV

Z-Transform: Basic principles of z-transform, z-transform definition, Relationship between z-transform and Fourier transform, Region of Convergence, Properties of ROC, Properties of z-transform, Poles and Zeros, Inverse z-transform using Contour integration, Residue Theorem, Power Series expansion and Partial fraction expansion.

Suggested Readings

1. Signals and Systems by Alan V. Oppenheim (Pearson Education)
2. Signals and Systems by Simon Haykin (John Wiley and Sons)
3. Linear Systems and Signals by B. P. Lathi (Oxford Publication)
4. Fundamentals of Signal and Systems using the Web and MATLAB by Kamen (Pearson)
5. Schaum's Outline of Signals and Systems by Hwei P. Hsu (TMH)

List of Experiments (Software using MATLAB)

1. Generation of Continuous Time and Discrete Time signals.
2. Implementation of Fourier Transform and Inverse Fourier Transform.
3. Implementation of Laplace Transform and Inverse Laplace Transform.
4. Implementation of Z – Transform and Inverse Z - Transform.
5. Implementation of Digital Filter (IIR and FIR Filters)

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Fundamentals of Digital Communication (DSE – 2/ GE – 4)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Digital Communication	4	3	0	1	Introduction to Analog Communication

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To understand importance of information theory in digital communication and various PCM Modulation
- To understand the variance basic concepts of digital communication.
- To understand the various digital Modulation-demodulation techniques.
- To understand various coding in digital communications.

Course Outcomes:

After completing the course, the students should be able to:

1. To understand the channel information carrying capacity and conversion of analog to digital signals.
2. To understand the effect of additive white Gaussian Noise on digital communication modulation techniques.
3. To analyse the effect of inter symbol interference as the source of channel impairment and the effect of multipath phenomenon.
4. To use and design communication systems for reliable communication.

Unit - I

Analog Pulse Modulation: Generation and Demodulation of Pulse Amplitude Modulation, Pulse Width Modulation, PCM and DPCM, PAM/TDM System, Spectra of Pulse Modulated Signals, SNR Calculations for Pulse Modulation Systems.

Unit - II

Digital modulation schemes: Coherent Binary Schemes: ASK, FSK, PSK. Coherent M-ary Schemes, Non-Coherent Schemes, Calculation of Average Probability of Error for Different Modulation Schemes, Power Spectra of Digitally Modulated Signals.
A discussion on various Modulation Schemes used in various standards such as GSM, IS-95, IS-56, CDMA.

Unit - III

Information Theory: Discrete messages, concept of amount of information and its properties. Average information, Entropy and its properties. Information rate, Mutual information and its properties. Source Coding: Introductions, Advantages, Shannon's theorem, Shanon-Fano coding, Huffman coding, efficiency calculations.

Unit - IV

Linear Block Codes: Introduction, Matrix description of Linear Block codes, Error detection and error correction capabilities of linear block codes, Hamming codes, Binary cyclic codes, Algebraic structure, encoding, syndrome calculation, BCH Codes.
Detection and Estimation: Review of Gaussian Random Process, Detection of Known Signals in Noise, Optimum Threshold Detection.

Suggested Readings

1. Digital Communication Systems by Simon Haykin; John Wiley and Sons.
2. Modern Digital and Analog Communication, 3rd Edition by B.P. Lathi (Oxford University Press)
3. Digital Communication by Sklar (Pearson)
4. Digital Communications by John G. Proakis (TMH)
5. Principles of Communication Systems by H. Taub and Schilling (TMH)

List of Experiments (Hardware on Breadboard / Software using NI Multisim/ MATLAB)

1. Study of PAM/PPM/PWM and Demodulation.
2. Study of an ASK and Demodulation.
3. Study of a PSK and Demodulation.
4. Study of FSK and Demodulation.
5. Study of Pulse Code Modulation
6. Study of Delta Modulation
7. Study of Adaptive Delta Modulation
8. Study of Companding
9. Source Encoder and Decoder
10. Linear Block Code-Encoder and Decoder
11. Binary Cyclic Code– Encoder and Decoder
12. Convolution Code– Encoder and Decoder

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Microelectronics Design (DSE – 2/ GE – 4)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Microelectronics Design	4	3	0	1	VLSI Technology and Design

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To understand device structure and properties of NMOMS, PMOS, and CMOS.
- To understand static and switching characteristics of CMOS Inverter.
- To design the CMOS based combinational and sequential circuits.
- To understand the concept of hierarchy, regularity, modularity, and locality.

Course Outcomes:

After completing the course, the students should be able to:

1. Characterize IC Technology.
2. Characterize Switching characteristics and Inter Connect Effects.
3. Design the CMOS based combinational and sequential circuits.
4. Perform gate level minimization and design various logic Gates.

Unit - I

Introduction: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS and BiCMOS. Technologies: oxidation, lithography, diffusion, ion implantation, metallization, encapsulation, probe testing, integrated resistors and capacitors. VLSI design flow, MOS transistor theory- MOS structure, enhancement and depletion transistor, threshold voltage, MOS device design equations, CMOS inverter- DC characteristics, static load MOS inverter, pull up/ pull down ratio, static and dynamic power dissipation, CMOS and NMOS process technology – explanation of different stages in fabrication, latch up, BiCMOS circuits and their characteristics.

Unit - II

Switching characteristics and inter connection effects: Rise time, fall time delays inverter design with delay constants, parasitic effect, super buffer. Clocked CMOS logic, pass transistor logic, domino, zipper CMOS, clocking strategies, clocked system, latches and registers, system timing set-up and hold timing, signal phase memory structure, 2 phase clocking, two phase memory structure.

Unit - III

Two phase logic structure, four phase memory and logic structure, design hierarchy, concept of regularity, modularity and locality, VLSI design style, design quality, computer aided design technology, design capture and verification tools. VLSI CIRCUIT DESIGN PROCESSES: MOS layers, stick diagrams, design rules and layout, CMOS design rules for wires, contacts, and transistors layout diagrams for NMOS and CMOS inverters and Gates, scaling of MOS circuits, limitations of scaling.

Unit - IV

GATE LEVEL DESIGN: basic circuit concepts, sheet resistance Rs and its concept to MOS, area capacitance units, delays, driving large capacitive loads, wiring capacitances, Fan in and fan out, typical NAND, NOR, delays, transistor sizing XOR, and XNOR gates, CMOS logic structures, CMOS complimentary logic, Pseudo NMOS logic. CMOS testing: CMOS testing, need for testing, test principles, design strategies for test, chip level test techniques, system level test techniques, layout design for improved testability.

Suggested Readings

1. Essentials of VLSI circuits and systems- Kamran Eshraghian, Dougles A. Picknell, and Sholeh Eshraghian, PHI, 2005
2. Principles of CMOS VLSI Design: A Systems Perspective –Neil H.E. West and Kamran Eshraghian, Pearson education, 1999.
3. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H. E. Weste and David Money Harris, Addison-Wesley (Pearson), 2011
4. VLSI Design, Debaprasad Das, Oxford University Press, 2015

List of Experiments

1. Input and Output characteristics of NMOS transistor.
2. Input and Output characteristics of PMOS transistor.
3. Input and Output characteristics of CMOS transistor.
4. Input and Output characteristics of BiCMOS transistor.
5. To understand the static and switching characteristics CMOS inverter. To measure propagation delay of CMOS circuit.
6. Design of Transmission Gate using CMOS
7. Design of NAND and NOR Gate using CMOS
8. Design of XOR and XNOR Gate using CMOS
9. Ring Oscillator using CMOS.
10. Observe pseudo NMOS logic.
11. Compute Fan In and Fan Out metrics.
12. To prepare layout for given logic function and verify it with simulations.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Introduction to IoT System Design (DSE – 2/ GE – 4)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to IoT System Design	4	3	0	1	Introduction to IoT

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- The focus of this introductory course would be "the smart sensor node" with emphasis on design, requirement, data interfacing and capabilities.
- Outline toe various IoT communication models and terminologies with networking and protocol considerations.

Course Outcomes:

After completing the course, the students should be able to:

1. Understand the working of different IoT communication models.
2. Understand the interfacing and communication of different sensors and actuators.
3. Innovate solutions for real – life problems through IoT.
4. Make right choice of hardware, software and protocols for the desired application.

Unit - I

Introduction to IOT (People Connecting to Things, Things Connecting to Things, Definition of IOT, History of IOT), IOT Components (Sensors and Actuators, Things, Communications Networks, The Internet, Protocol Stack), IOT Communication Models, IOT Applications, IOT Companies, Baseline Technologies (Machine to Machine(M2M)Communication, Web of Things (WOT)), Address Crunch in IOT, IOT Terminologies (IOT Node, LAN, MAN and WAN, IOT Gateway and Proxy), IOT Network Configuration (Gateway Prefix Allotment, Impact of Mobility on Addressing, Concept of Tunneling Multi homing), IPv4 Versus IPv6.

Unit - II

Introduction to IOT Networking, Networking Standards and Technologies (Network Access and Physical Layer, Internet Layer, Transport Layer, The application layer), IOT Networking Protocols, Network Access and Physical layer IoT Network Technologies ((LPWAN (Low Power Wide Area Network), Cellular, Bluetooth Low Energy (BLE), RFID, NFC, Zigbee, Wifi, Ethernet), Internet layer IoT network technologies (IPv6, 6LoWPAN, and RPL), Application layer IoT network technologies (HTTP, HTTPS, MQTT, AMQP, and XMPP), IoT networking considerations and challenges, IoT Platforms Capabilities.

Unit - III

Introduction to Arduino (Different Arduino boards, Arduino Uno board description and its pin configuration, Arduino IDE and program uploading, different functions related to GPIOs and special functions (PWM and Serial communication), Interrupts, Introduction to NodeMcu (board description and pin configuration), Integration of NodeMcu in Arduino IDE, Interfacing with Arduino/NodeMcu using processing language (LED, Switch, Seven Segment, LCD, DC Motor, Relay, IR, LDR and DHT11 sensor), use of simulator and compiler, Configuring Node Mcu as Wi fi Module (ESP8266).

Unit - IV

Basics of HTML programming (elements, attributes, paragraph, image etc), CSS, Tables and Forms, Creating local server and webserver using Node Mcu, Creating a Web page to control actuator Wi fi, Introduction to Thing speak Cloud Platform (creating account and configure channel for live data feed, Concept of Write and Read APIs), Case Studies: Controlling an actuator connected to Node Mcu using remote web interface via cloud, Visualization of sensor data on the cloud and integrate them onto the webpage, Introduction to IFTTT and Ada fruit IO (creating account and configuration), Controlling home appliances using Google Assistant AI application via IFTTT and Adafruit I/O (MQTT protocol).

Suggested Readings

1. Internet of Things: A Hands-on Approach by Arshdeep Bahga and Vijay Madisetti (University Press)
2. The Internet of Things: Enabling Technologies, Platforms, and Use Cases by Pethuru Raj and Anupama C. Raman (TandF – CRC Press)
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, “Internet of Things,” John Wiley and Sons.
4. Cuno Pfister, “Getting Started with the Internet of Things”, Shroff Publisher/Maker Media.

List of Experiments (Hardware based – Arduino Uno)

1. Interfacing of Arduino Uno with LED.
2. Interfacing of Arduino Uno with DC Motor.
3. Interfacing and Application of various sensors using Arduino Uno.
4. Configuring and Interfacing of Wi-Fi module with Arduino Uno.
5. Interfacing of Bluetooth Module with Arduino Uno and Application.
6. Interfacing of ZigBee module with Arduino Uno and Applications.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Image Filtering and Restoration (DSE – 2/ GE – 4)
(Credit Distribution and Prerequisites of the Course)

Course Title	Credits	Credit Distribution of the Course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Image Filtering and Restoration	4	3	0	1	Fundamentals of Image Processing

Course Hours: L – 03, T – 00, P - 02

Course Objectives:

- To study image enhancement techniques.
- To study image restoration procedures.
- To study the various transformation techniques used for filtering and restoration.

Course Outcomes:

After completing the course, the students should be able to:

1. Understand the basic concepts of image filtering and restoration techniques.
2. Analyze different types of noise and artifacts present in images.
3. Apply various image filtering techniques to enhance image quality.
4. Implement image restoration algorithms to recover degraded images.

Unit - I

Fundamentals of Image Filtering and Restoration: Introduction to image processing, image enhancement vs. image restoration, image degradation processes, noise models, point processing techniques, spatial domain vs. frequency domain methods.

Unit - II

Image Filtering Techniques: Convolution and correlation, linear and nonlinear filters, mean and order statistics filters, Gaussian and adaptive filters, edge enhancement filters, morphological filters, filter design and analysis.

Unit - III

Noise Reduction and Restoration: Noise reduction methods, types of noise (additive, multiplicative, impulse), spatial domain noise reduction filters (median, adaptive median, Wiener), frequency domain noise reduction (FFT-based filtering), restoration process overview, inverse filtering, least squares filtering, constrained least squares filtering.

Unit - IV

Advanced Restoration Techniques: Blind deconvolution, Wiener deconvolution, regularization methods (Tikhonov, total variation), image denoising algorithms (BM3D, wavelet denoising), image inpainting, super resolution techniques, case studies in image restoration.

Suggested Readings

1. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Prentice Hall, 3rd Ed.
2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.
3. S. Sridhar, Digital Image Processing, Oxford University Press.
4. R. C. Gonzalas, “Digital Image Processing using MATLAB,” McGraw Hill.
5. W. K. Pratt, “Digital Image Processing,” Wiley

List of Experiments/ Practical (Based on MATLAB)

1. Study the histogram plot of different noise sources added to a standard image.
2. DFT analysis of Images.
3. Intensity transformation of Images.
4. Histogram Processing and Thresholding techniques.
5. WAP to implement spatial filtering (image enhancement).
6. WAP to implement filtering in frequency domain (image enhancement).
7. WAP to restore a noisy image.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercises.)

Annexure-2

Department of Electrical Engineering
Faculty of Technology
University of Delhi
Detailed Course Structure and Curriculum of B.Tech. (EE) Second Year

Department of Electrical Engineering
Faculty of Technology
University of Delhi

Course Structure of B. Tech. (EE) Second Year

Semester III						
S. No.	**Course Domain**	**Course Title**	**Credits***			**Total Credits**
			L	**T**	**P**	
1	DSC-7	Electrical Network Analysis	3	0	1	4
2	DSC-8	Electrical Machines I	3	0	1	4
3	DSC-9	Analog and Digital Electronic Circuits	3	0	1	4
4	DSE-1 or GE-3	Select a course from the specified list of DSE-1 or Select a course from the specified list of GE-3				4
5	AEC	Select a course from the specified list of AECs				2
6	SEC / IAPC	Choose one SEC or Internship / Apprenticeship / Project / Community Outreach (IAPC)				2
7	VAC	Select a course from the specified list of VACs				2
					Total Credits	**22**

Semester IV						
S. No.	**Course Domain**	**Course Title**	**Credits***			**Total Credits**
			L	**T**	**P**	
1	DSC-10	Electrical Machines II	3	0	1	4
2	DSC-11	Power Transmission and Distribution	3	0	1	4
3	DSC 12	Electrical and Electronic Measurements	3	0	1	4
4	DSE-2/ GE-4	Select a course from the specified list of DSE-2 or Select a course from the specified list of GE-4				4
5	AEC	Select a course from the specified list of AECs				2
6	SEC / IAPC	Choose one SEC or Internship / Apprenticeship / Project / Community Outreach (IAPC-2)				2
7	VAC	Select a course from the specified list of VACs				2
					Total Credits	**22**

**Credits*
L (01 Credit) is equivalent to 01 contact hour per week.
T (01 Credit) is equivalent to 01 contact hour per week.
P (01 Credit) is equivalent to 02 contact hours per week.

Department of Electrical Engineering
Faculty of Technology
University of Delhi

Pool of DSEs offered by the Department of Electrical Engineering in Second Year

S. No.	Semester	DSE	Course Title
1.	III	DSE-1	Non-Conventional Energy Resources
2.			Signal and Systems
3.	IV	DSE-2	Electrical Machine Design
4.			Electrical Engineering Materials

List of SECs offered by the Department of Electrical Engineering in Second Year

S. No.	Semester	Course Title
1.	III	Advanced Electrical Workshop-I
2.	IV	Pspice Modelling for Electrical Circuits

Department of Electrical Engineering
Faculty of Technology
University of Delhi

Specializations and Minor offered by the Department of Electrical Engineering

S. No.	Sem	DSE/ GE	Minor in EE (Open only for CSE/ ECE)	Specializations for EE / Minors for ECE and CSE		
				Robotics and Automation	**Sustainable Energy Engineering**	**Electric and Hybrid Vehicle**
1	III	DES-1/ GE-3	Fundamentals of Electrical Circuits	Fundamentals of Signal and Systems	Energy and Its Resources	Introduction to Electric and Hybrid Vehicles
2	IV	DSE-2/ GE-4	Electro-Mechanical Energy Conversion	Sensors and Transducers	Design and Evaluation of Photovoltaic Power Plants	Electric Vehicle Motor

Detailed Syllabus of Discipline Specific Core (DSC) Courses of B. Tech. (EE) – SEMESTER III

Electrical Network Analysis (DSC-7)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical Network Analysis	4	3	0	1	Introduction to Electrical and Electronics Engineering, Mathematics-I

Course Hours: L-03, T-00, P-02

Course Objectives:

1. To solve different complex circuits using various network reduction techniques such as Source Transformation, Network theorems etc.
2. To understand basic concepts of DC and AC circuit behavior.
3. To analyze the transient response of series and parallel A.C. circuits and to solve problems in time domain using Laplace Transform.
4. To analyze two port circuit behaviors.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Acquire and demonstrate the knowledge of circuit elements, different laws and resonating behavior of circuits.
2. Apply the knowledge of basic circuit law to simplify the networks using network theorems.
3. Analyze the RL, RC and RLC circuits using Laplace transform and waveform Synthesis.
4. Analyze the transient, steady state of RL, RC and RLC circuits for AC and DC excitations.
5. Analysis of various two port networks with their connection, interrelationships and interconnection of two port networks (with respect to impedance, admittance, hybrid and transmission parameters).

UNIT-I

Introduction to AC circuits: Review of AC Circuits and Introduction to three phase circuits, Series and parallel resonance, frequency response of series and Parallel circuits, Q–Factor, Bandwidth.
Magnetically coupled circuits: Dot convention, Self and Mutual Inductance, Energy in a coupled circuit.

UNIT-II

Network Theorems for AC & DC circuits: Node and Mesh analysis, Thevenin's & Norton's Theorems, Superposition Theorem, Reciprocity, Compensation, Substitution, Maximum power transfer, Millman's and Tellegen's theorems. Examples with dependent & independent energy sources.
Network Topology: Concept of Network graph, Tree, Tree branch & link, Incidence matrix, cut set and tie set matrices.

UNIT-III

Laplace Transforms and properties: Initial conditions in networks and network solution with Laplace transformation, step, ramp and impulse functions, initial and final value theorem, waveform Synthesis

Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations.

UNIT-IV

Two port networks: Network & Transfer functions for one port & two ports, poles and zeros, Necessary condition for driving point & transfer function. Two port parameters – Z, Y, ABCD, Hybrid parameters, their inverse & image parameters, relationship between parameters, Interconnection of two ports networks, Terminated two port networks.

Filter circuits: Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier. Solution of Problems.

Suggestive Readings:

1. Lawrence P. Huelsman, Basic Circuit Theory, Prentice Hall India Learning Private Limited; 3rd edition.
2. William H. Hayt, Jack Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill Education; Eighth edition (4 August 2013).
3. Raymond A. DeCarlo, Pen-Min Lin, Linear Circuit Analysis, OUP USA; 2nd edition.
4. M.E. Van Valkenburg, Network Analysis, PHI Learning, 3rd Edition, 2010.
5. William D Stanley: Network Analysis with Applications, Pearson Education, 4th Edition, 2013.

List of Experiments:

1. To verify the Thevenin's/Norton's Theorem.
2. To verify the Superposition Theorem.
3. To verify the Maximum Power Transfer Theorem.
4. To verify Reciprocity Theorem.
5. To verify the Millman's Theorem.
6. To verify the Tellegan's Theorem.
7. To construct RL & RC transient circuits and to draw the transient curves.
8. To obtain the resonance frequency of the given RLC series electrical network.
9. To determine open circuit parameters and short circuit parameter of the given two-port network.
10. To calculate and verify 'ABCD' parameters of a two-port network.
11. To calculate and verify Hybrid parameters of two-port network.
12. Frequency response of first order low pass and high pass filters.
13. Frequency response of first order band pass and band reject filters.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Electrical Machines I (DSC-8)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical Machines I	4	3	0	1	Introduction to Electrical and Electronics Engineering, Mathematics-I

Course Hours: L-03, T-00, P-02

Course Objectives:

To make the students familiar with the fundamentals of various type of DC machines and transformers both of which are important entities in the field of Electrical Engineering.

Course Outcomes:

At the end of this course, students will be able to:

1. Analyse the series and parallel magnetic circuits from the point of view of electrical machines and transformers. Students will also learn the concept of field energy and co - energy helpful in design of machines at a later stage.
2. Understand the intricate details of the construction of DC machines, needed in the design and fabrication of DC generators. Knowledge of the armature winding will enable the students to perform fault finding in the armature.
3. Gain complete knowledge of communication in DC machines to enable them to improve the performance of DC machines. The students will also learn the characteristics of DC Motors, a knowledge which will help them to select appropriate motor for a specific application.
4. Gain knowledge of various aspects of single and three-phase transformers, helping them to compute their performance in respect of voltage regulation efficiency, and also select proper type of three-phase connections for specific purpose.

UNIT-I

Electromechanical Energy Conversion: Law of conservation of Energy, Series and Parallel Magnetic Circuits, analogy with electric circuits. Energy stored in magnetic field, concept of co-energy. Energy conversion in singly excited and doubly excited systems. Production of Torque in Electromagnetic systems. Reluctance Torque.

UNIT-II

DC Machines: Constructional features of DC Machines. Types of field coils and their placement on stator. Lap and Wave Windings on armature. Concept of parallel paths.
DC Generators: EMF equation of a DC generator. Methods of excitation; shunt, series and compound generators and their characteristics.

UNIT-III

Commutation in DC Machines: Interaction between fields produced by field and Armature circuits. Phenomenon of commutation, Causes, effect and remedy for bad commutation.
DC Motors: Torque Equation of D.C. Motor, Concept of Back EMF. Methods of excitation of dc motors. Characteristics of shunt, series and Compound Motors. Starting & speed control of DC Motors, Testing of DC Machines.

UNIT-IV

Single phase transformers: Construction of Transformers. No load and load operation. Equivalent circuits and phasor diagrams, Voltage regulation, losses and efficiency. All day Efficiency of a transformer.

Testing of transformer: OC/SC Tests, Sumpner's test.

Three phase transformers: Three phase bank of single-phase transformers. Conditions of parallel operation of single phase & 3 phase transformers various types of winding connections of three phase transformers. Auto transformers: Construction operation , comparison with two winding transformers

Suggestive Readings:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2011.

List of Experiments:

1. Magnetising characteristic of DC machines.
2. Load characteristic of DC shunt generator.
3. Load characteristic of DC compound generator.
4. Speed control of DC shunt motor.
5. Swinburn's test on a DC shunt motor.
6. Load Test on a DC shunt motor.
7. OC and SC test on a single-phase transformer.
8. Load test on a single-phase transformer.
9. Parallel operation of two single phase transformers.
10. Study of three phase connections of transformers.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Analog and Digital Electronic Circuits (DSC-9)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Analog and Digital Electronic Circuits	4	3	0	1	Introduction to Electrical and Electronics Engineering, Physics, Mathematics-I

Course Hours: L-03, T-00, P-02

Course Objectives:

This course is intended to develop an understanding of small signal amplifier design using linear transistor models; and its analysis at low and high frequencies, including different feedback topologies and oscillators. The course also indulges power amplifiers, tuned amplifiers and behavior of noise in an amplifier.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Explain the basic concepts of BJT, MOSFET with their h parameter modelling.
2. Analyze the working principles of wave shapers and negative amplifiers.
3. Describe and compare the Bi-stable, Mono-stable and Astable circuits and its applications.
4. Explain the ideal and practical Op-Amp characteristics and perform the various Op-Amp circuits in different applications.

UNIT-I

Introduction to OP-Amp: Introduction, Block Diagram Representation of a Typical OP-Amp, Operational amplifier characteristics, slew rate, bandwidth, offset voltage, basic applications inverting, non-inverting amplifier and its application summing amplifier, differentiator, integrator, differential amplifier, instrumentation amplifier, log and antilog amplifier, voltage to current and current to voltage converters, comparators Schmitt trigger.

UNIT-II

Voltage Controlled Oscillator, precision rectifiers, sample and hold circuit, basic op-amp comparator circuit, zero crossing detector, function generator, peak detectors, analog and digital converters and digital to analog converters, 555 timer and its applications, phase locked ICs (PLL).

UNIT-III

Combinational circuits: Review of number systems and mutual conversion, Boolean algebra, Minterms and maxterms, Truth table and Karnaugh mapping, reduction of Boolean expression with SOP, POS and mixed terms.

Encoder/Decoder and Codes Encoders, Decoders, Multiplexers, Demultiplexers, code convertors, Half adder and full adder, parity checker/ generator, programming logic Array (PLA).

UNIT-IV

Sequential circuits: State tables and diagrams, flip flop and its various types- JK, RS, T, D, pulse and edge triggered flip flops transition and excitation tables, timing diagrams.

Shift registers: Series and parallel data transfer, asynchronous and synchronous counters, ripple counter, Modulo N counter design, up down counters, Ring counter, DAC and ADC.

Suggestive Readings:

1. Behzad Razavi, "Fundamentals of Microelectronics", Wiley India Pvt. Ltd. 2009.
2. S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford university Press, 6th Edition 2013.
3. Robert L Boylestad and Louis Nashelsky, "Electronic Devices & Circuit Theory", PHI 2001.
4. B. G. Streetman and S. Banerjee, "Solid State Electronic Devices", 7th ed., Pearson Ed, 2014.
5. Digital Logic and Computer Design, M. Morris Mano, Pearson Education.
6. Digital Fundamentals, T. L. Floyd, Pearson Education.

List of Experiments:

1. To study operational amplifier as inverting & non inverting amplifier & calculate gain.
2. To study and observe operational amplifier as a differentiator and integrator.
3. To study and observe operational amplifiers as summing amplifier & difference amplifiers.
4. To study operational amplifiers as comparator & Schmitt trigger.
5. To design an operational amplifier circuit for scaling and averaging.
6. Implementation of adder and subtractor circuits on breadboard.
7. Implementation of 4×1 Multiplexer on breadboard.
8. Implementation of 3-bit Binary to gray code converter circuit on breadboard.
9. Analysis of flip-flop using kit.
10. Implementation of 7-segment display using up counter.
11. Analysis of up and down synchronous/ asynchronous counter using kit.
12. To Study and perform the conversion using the A/D and D/A converter.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Detailed Syllabus of Discipline Specific Elective (DSE) courses for B.Tech. (EE) – SEMESTER III

Non-Conventional Energy Resources (DSE-1)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Non-Conventional Energy Resources	4	3	1	0	Nil

Course Hours: L-03, T-01, P-00

Course Objectives:
Examine diverse energy sources and their environmental impact. Analyze energy conversion processes. Foster critical thinking for sustainable energy resources.

Course Outcomes:
At the end of this course, students will demonstrate the ability to:

1. Identify renewable energy sources and their utilization.
2. Understand the basic concepts of solar radiation and analyze the working of solar and thermal systems.
3. Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas and hydrogen.
4. Identify methods of energy storage for specific applications.

UNIT-I

Principles of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data.

Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT-II

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/cooling techniques, solar distillation and drying, photovoltaic energy conversion.

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

UNIT-III

Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of biogas, utilization for cooking, I.C. Engine operation, and economic aspects.

UNIT-IV

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. Ocean Energy – OTEC, Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave energy: Potential and conversion techniques, mini-hydel power plants, their economics.

Suggestive Readings:

1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Non- conventional Energy Sources / G.D. Rai/ Khanna Publishers
3. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon.
4. Renewable Energy Sources / Twidell & Weir
5. Solar Power Engineering / B.S. Magal Frank Kreith & J.F. Kreith
6. Principles of Solar Energy / Frank Krieth & John F Kreider
7. Non-Conventional Energy / Ashok V Desai / Wiley Eastern
8. Non-Conventional Energy Systems / K Mittal / Wheeler
9. Renewable Energy Technologies / Ramesh & Kumar / Narosa

Signal and Systems (DSE-1)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Signal and Systems	4	3	1	0	Introduction to Electrical and Electronics Engineering, Mathematics-I

Course Hours: L-03, T-01, P-00

Course Objectives:

1. To understand the classification of signals, systems, impulse response, convolution, LTI systems, Fourier series and Fourier transform.
2. To learn the concepts of Laplace transforms, z-transforms, sampling, and its applications.
3. To understand the sampling and its applications.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Acquire and demonstrate the knowledge of knowledge of various signals, systems, convolution and LTI systems.
2. Apply the knowledge of analyze the spectral characteristics of signals using Fourier series, Fourier transforms, Laplace transforms and z-transforms.
3. Understand sampling which will also help understand other introductory courses.

UNIT-I

Types of Signals and Systems and Their Representation

Continuous-time and discrete-time signals, energy and power of signals, periodic-aperiodic signals, even-odd signals, standard signals: unit impulse, unit step, ramp, exponential and sinusoids. Transformations of the independent variable, continuous and discrete time systems, system properties.

UNIT-II

LTI Systems

Impulse response, convolution integral and convolution sum, LTI systems' properties, LTI system characterization by linear constant coefficient difference equation.

Fourier Series and Fourier Transform of Signals

Fourier series representation of continuous and discrete time periodic signals, convergence, properties of Fourier series, Fourier series and LTI systems, Application of Fourier series in filtering, Fourier transform representation of continuous and discrete time signals, Fourier transform properties, Hilbert transform and its properties, system characterization by linear constant coefficient difference equation.

UNIT-III

Laplace and Z-Transform

The Laplace transform, region of convergence, properties of Laplace transform, initial and final value theorem, inverse Laplace transform, system functions, poles and zeros of system functions, analysis and characterization of LTI systems using Laplace transform, z-transform, region of convergence and pole-zero plot for z-transform, properties of z-transform, analysis and characterization of LTI systems using z-transform, stability criterion.

UNIT-IV

Sampling and Reconstruction

Sampling Theorem, classification of sampling, aliasing, anti-aliasing filter, analog to digital conversion, signal reconstruction.

Suggestive Readings:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, "Signals and Systems", Prentice Hall, 2nd Edition.
2. S. Haykin and B. Van Been, "Signals and Systems", John Wiley & Sons, 2nd Edition, 2003.
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2nd edition, 2006.

Detailed Syllabus of Discipline Specific Core (DSC) courses for B.Tech. (EE) – SEMESTER IV

Electrical Machines II (DSC-10)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical Machines II	4	3	0	1	Electrical Machine I

Course Hours: L-03, T-00, P-02

Course Objectives:
To make the students familiar with the fundamentals of various type of Induction machines both three phase and single phase and synchronous machines both of which are important entities in the field of Electrical Engineering.

Course Outcomes:
At the end of this course, students will demonstrate the ability to:

1. Understand AC machine windings.
2. Concept of rotating magnetic fields.
3. Understand the operation of AC machines.
4. Analyze performance characteristics of AC machines.

UNIT-I

Constructional features of squirrel cage and slip ring induction motors. Poly-phase AC windings. Production of rotating magnetic field and operation-of 3 phase Induction Motors. Concept of slip. Power flow stages in an induction motor. Equivalent circuit. Phasor diagram. Power, torque and slip relations. Torque slip characteristics Generator action. Line connected and self-excited induction generators.
Various methods of Starting, speed control and braking of Induction motors. No load and blocked rotor tests on Induction motors. Computation of Equivalent circuit parameters. Deep bar and Double cage rotors. Clogging and crawling of Induction motors.

UNIT-II

SYNCHRONOUS GENERATORS (Alternators)
Constructional features. Armature winding (extension of what was discussed in Unit-I) Generations of EMF. Pitch and distribution coefficients.
Harmonics in induced emf. Armature Reaction and its effects. Open Circuit and short circuit tests. Various methods of determining Voltage regulation. Parallel operation and operation on an infinite bus. Two reaction theory. Power expressions for salient pole and cylindrical rotor machines. Performance characteristics.

UNIT-III

SYNCHRONOUS MOTORS

Construction and principle of operation. Starting methods. Phasor diagram. Torque- angle characteristic. V-curves, hunting and damping. Synchronous motor as a condenser. Single phase synchronous motors: Reluctance and Hysteresis motors.

UNIT-IV

SINGLE PHASE INDUCTION MOTORS AND OTHER FRACTIONAL-HORSEPOWER (FHP) MOTORS

Single Phase Induction motors: Nature of field produced by one single phase winding on stator. Double revolving field theory, Equivalent circuit, Torque speed characteristics.

No load and blocked rotor tests. Split phase starting, various types of capacitor motors.

Other motors; -

Shaded pole motor, Universal motor, AC servo motor, Stepper motor, Switched reluctance motor, Hysteresis motor, BLDC motor.

Suggestive Readings:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
5. A.S. Langsdorf, "Theory of AC Machines," Tata McGraw-Hill Publishing Company Limited
6. Cyril G. Veinott. And Joseph E. Martin, "Fractional and Sub fractional horse power Electric Motors," Tata McGraw-Hill.
7. S. J. Chapman, "Electrical Machinery Fundamentals," Tata McGraw-Hill, 2005.
8. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
9. P. S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2011.

List of Experiments:

1. To Study Open Circuit & Short Circuit Tests on Three Phase Alternator, and determine its voltage Regulation by synchronous impedance method.
2. To perform Load Test on Three Phase Alternator.
3. To Study the reactance, Xd & Xq of Three Phase Alternator.
4. To perform Load Test on Three Phase Induction Motor (through Electrical Loading) and obtain Torque speed curve.
5. To perform No Load & Blocked Rotor Tests on Three Phase Induction Motor (Mechanical Loading) and get equivalent circuit parameters.
6. To perform speed control of a Three Phase Induction Motor by (a) keeping v/f ratio constant (b) By changing frequency at the rated voltage.
7. Make connection of DOL Starter, Star-Delta Starter & through VFD for three phase induction motor.
8. To perform Load Test on Three Phase Slip-ring Induction Motor and get speed Torque characteristics.
9. To perform No Load & Blocked Rotor Test on Three Phase slip ring Induction Motor and get equivalent circuit parameters.
10. To control the Speed of a three Phase Slip ring Induction Motor by varying resistance in the rotor circuit.
11. To perform Load Test on Single Phase Induction Motor.
12. To perform No Load & Blocked Rotor Tests on Single Phase Induction Motor
13. To Study the effect of Capacitor on the performance of the Motor and to change the direction of rotation.

14. To test the performance of a synchronous motor at different load conditions and to see the effect of variation of excitation and power factor (V curve & Inverted V Curve).

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Power Transmission and Distribution (DSC-11)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Power Transmission and Distribution	4	3	0	1	Introduction to Electrical and Electronics Engineering, Electrical Network Analysis

Course Hours: L-03, T-00, P-02

Course Objectives:
To make students familiarize with the structure of a power system network, its different components like transmission lines, underground cables, insulators and the performance evaluation of the transmission lines.

Course Outcomes:
At the end of this course, students will demonstrate the ability to:

1. To get introduced with the basics of power transmission systems.
2. To be familiar with the distribution systems.
3. To analyze performance of transmission systems through modeling.
4. To know design and physical construction of overhead lines and underground cables.
5. To be aware of phenomena of surges and travelling waves in high voltage transmission systems.

UNIT-I
Introduction to Transmission and Distribution Systems: Structure of a power system, equipment for substations, general layout; radial, ring mains, sub-transmission, primary and secondary distribution systems; calculation of line resistance (skin and proximity effect), inductance and capacitance of single-phase and three-phase, single circuit and double circuit transmission lines.

UNIT-II
Performance of Transmission Lines: Models of short, medium and long transmission lines including A, B, C, D constants; Ferranti effect, regulation and efficiency, tuned power lines, power flow through a transmission line, power circle diagrams, and transmission loss; transposition of conductors, surge impedance loading, formation of corona, critical voltage, methods of reduction – bundle conductor, effect online performance and interference.

UNIT-III
Overhead Lines and Underground Cables: Overhead line supports (towers), conductors, insulating materials and insulators - voltage distribution over suspension insulator string, equalizer ring, string efficiency, testing of insulators; conductor sag-tension calculations, effects of wind and ice loading, vibration dampers. Types of LV and HV underground cables and insulation – solid, liquid, gaseous, dielectric stress, dielectric loss, heating of cables, grading of cables, measuring insulation resistance, and capacitances of single-phase and three-phase cables, charging current in a cable and rating, failure due to tree formation.

UNIT-IV
Surge Performance and Protection: Switching surges, origin and mechanism of lightning strokes, direct and induced strokes, protection from surges - lightning arrestors (rod gap, horn gap, multi-gap and expulsion type) and surge diverters, evaluation of surge impedance, energy and power associated with a surge.

Traveling Waves: Theory of traveling waves, wave equation, role of characteristic impedance of a line, incident and reflected waves, transmission and refraction of waves, Bewley Lattice Diagram, velocity of traveling waves, behavior of traveling waves for different terminations - inductor, capacitor, open-end, short-end, cable while approaching substation and over the junction of dissimilar lines, attenuation of traveling waves.

Suggestive Readings:

1. Hadi Saddat, "Electric power systems", Tata McGraw Hill. 2014.
2. Abhijit Chakraborty, and Sunita halder, "Power System Analysis, Operation and Control", PHI, New Delhi, 2011.
3. W. H. Stevension, "Elements of Power System Analysis", McGraw Hill, 1982.
4. C. L. Wadhava, "Electrical Power Systems", New Age International, 2004.

List of Experiments:

1. To study and testing of typical Radial DC Distribution system supplied from one as well as both ends.
2. To study and testing of typical Ring main DC Distribution system.
3. Study of Short Transmission Line for calculation of various parameters.
4. Ferranti Effect of Single-Phase Transmission Line.
5. P-V Characteristics of Single-Phase Transmission Line.
6. Simulation of String of Insulators with and without Guard Ring and evaluating its efficiency.
7. Measurement of Capacitance of Three-Core Cable.
8. Determination of Voltage Drop in a Cable.
9. To determine the dielectric strength of the given transformer oil using Oil testing Kit.
10. Calculate the corona loss of transmission line and show the effect of different factors affecting corona losses.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Electrical and Electronic Measurements (DSC-12)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical and Electronic Measurements	4	3	0	1	Introduction to Electrical and Electronics Engineering

Course Hours: L-03, T-00, P-02

Course Objectives:
To make students familiarize with different types of error in measurements, analog type measuring instruments, different ways of power, energy, resistance, inductance and capacitance measurement.

Course Outcomes:
At the end of this course, students will be able to:

1. Classify various measuring instruments used to measure electrical quantities.
2. Apply methods for the measurement of resistance, capacitance and inductance.
3. Choose the suitable current and potential transformers.
4. Measure and analyze the error free currents and voltages.

UNIT-I
Preliminaries: Concepts of Measurements & Measurement Systems: Introduction to measurement and instrumentation, S. I. system, methods of measurement, static and dynamic characteristics of instruments, definitions – true value, accuracy, error, precision, sensitivity, resolution etc.
Analog Electromechanical Instruments: Classification of analog instruments, principle of operation, operating forces, errors in ammeters and voltmeters. Permanent magnet moving coil, moving iron, dynamometer type, induction type, electrostatic type instruments.

UNIT-II
Potentiometers: Principle of D. C. potentiometer, direct reading potentiometers, accurate forms of potentiometers, A. C. potentiometer principle, polar and Co - ordinate type A. C. potentiometer, applications of A. C. and D. C. potentiometers.
Measurement of Power and Energy: Electrodynamometer type wattmeter, measurement of power in three phase circuits, three phase wattmeter, measurement of reactive power, energy meter for A.C. circuits, induction type energy meter.

UNIT-III
Measurement of Resistance: Measurement of low, medium & high resistances, insulation resistance measurement, localization of cable fault, Loop tests.
Measurement of Inductance and Capacitance: A. C. bridges for inductance measurement – Maxwell, Hays, Anderson and Owen bridges, capacitance measurement – De Sauty and Schering Bridge. Measurement of frequency by Wien's bridge.

UNIT-IV

Magnetic Measurements: Magnetic measurement using Ballistic Galvanometer, Grassot Flux meter, BH curve of magnetic material, separation of losses.
Instrument Transformers: Current and Potential transformers, ratio and phase angle errors, design considerations, numerical problem.
Electronic Measurements: Electronic voltmeter, multi meter, wattmeter and energy meter. Time, Frequency and Phase Angle meters; CRO, Storage oscilloscope, Spectrum and Wave analyzer.

Suggestive Readings:

1. Introduction to Modern Electronic Instrumentation and Measurement Techniques: Helfrick and Cooper, Prentice Hall of India, 1997.
2. Instrumentation Measurement and Feedback: Jones, B. E., Tata McGraw-Hill, 1995.
3. Electrical Measurement and Measuring Instruments: Golding, E. W., Sir Issac Pitman & Sons., 3rd Edition.
4. A course in Electrical and Electronic Measurement and Instrumentation: A. K. Sawhney, Dhanpat Rai Publication.

List of Experiments:

1. Calibration of voltmeter and Ammeter.
2. Calibration of single phase A.C. Energy meter.
3. Three phase power measurement by two wattmeter method.
4. Measurement of reactive power using single wattmeter in three-phase circuit.
5. Measurement of percentage ratio error and phase angle of given C.T. by Silsbee's method.
6. Extension of instrument ranges using C.T. and P.T.
7. Measurement of resistance using Kelvin's Double Bridge.
8. Measurement of earth resistance using Meggar.
9. Measurement of self-inductance and Quality factor using Anderson Bridge.
10. Measurement of capacitance using Schering Bridge.
11. Measurement of voltage, current and resistance using DC potentiometer.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Detailed Syllabus of Discipline Specific Elective (DSE) courses for B.Tech. (EE) – SEMESTER-IV

Electrical Engineering Materials (DSE-2)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical Engineering Materials	4	3	1	0	Introduction to Electrical and Electronics Engineering, Physics

Course Hours: L-03, T-01, P-00

Course Objectives:

1. To know about different materials used in Electrical Engineering and their properties.
2. To understand conductive nature of a metal and its principle.
3. To analyze the magnetic and dielectric properties of different materials.
4. To know about the behaviors of different semiconductor materials.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Acquire and demonstrate the knowledge of different materials used in electrical equipment.
2. Analyze different materials based on their conductive, dielectric and magnetic properties.
3. Uses the knowledge of semiconductor materials in design and fabrication of chips.
4. Analyze the electric equipment and do proper deign of that with exact material.

UNIT-I

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects.

UNIT-II

Dielectric Properties of Materials: Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferroelectricity, piezoelectricity.

UNIT-III

Magnetic properties of Materials: Introduction, Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

UNIT-IV

Semiconductor Materials: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

Suggestive Readings:

1. C. S. Indulkar and S. Thiruvengadam, "An Introduction to Electrical Engineering Materials," S. Chand Publication
2. Kenneth G. Budinski, Michael K. Budinski, "Engineering Materials: Propertise and Selection," Prentice Hall of India, New Delhi
3. S. P. Seth, "A Course in Electrical Engineering Materials," Dhanpat Rai Publication

Electrical Machine Design (DSE-2)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electrical Machine Design	4	3	1	0	Electrical Machines I

Course Hours: L-03, T-01, P-00

Course Objectives:

1. To understand the design concepts of transformers and know about how to design the parts.
2. To understand the design of various parts of DC machines and solve the problems of design.
3. To analyze the design concepts of induction motors and solve the problems related to design.
4. To know importance of design of machines based on their applications using computer tools.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Classify the materials used for construction of electrical machines.
2. Assess and examine the design, performance of transformer.
3. Develop the overall dimensions of a rotating machine.
4. Analyze the design and performance of rotating machines.

UNIT-I

Fundamental Aspects of Electrical Machine Design: Design of machines, design factors, limitation in design, modern trends in electrical machine design, types of magnetic, electric and insulating materials, modes of heat dissipation, cooling of rotating machines Computer Aided Design (CAD) of Electrical Machines Limitations and assumptions in traditional designs, need of CAD.

UNIT-II

Design of Transformers: Transformer windings, output equation, design of main dimensions, design of core, choice of flux density, determination of number of turns and length of mean term, resistance and leakage reactance, no load current calculation, cooling of transformers, calculation of number of tubes.

UNIT-III

Design of DC Machines: Output equation, selection of specific magnetic and electric loadings, separation of D and L, estimation of number of conductors, armature slots and conduct dimensions, choice of number of poles and calculation of length of airgap, design of field systems, interpoles and brushes.

UNIT-IV

Design of Induction Motors: Output equation, main dimensions, choice of average flux density and ampere conduction for meter, design of stator slots and rotor slots, design of rotor bars end rings, design of wound rotor, design of no-load current.

Suggestive Readings:

1. M. Ramamoorty, Computer Aided Design of Electrical Equipment, Eastern Press Private Limited (1989).
2. AK. Sawhney, a Course in Electrical Machine Design, Dhanpat Rai & CO. (2013).
3. M. G. Say, Design and Performance of Machines, CBS Publications (1981).
4. E. S. Hamdi, Design of Small Electrical Machine, John Wiley and Sons (1994).

Department of Electrical Engineering
Faculty of Technology
University of Delhi

List of Discipline Specific Elective (DSE)/ Generic Elective (GE) courses offered for Minors / Specializations by the Department of Electrical Engineering in Second Year

1. **Minor in EE (Offered to ECE and CSE)**
    a. DSE-1/ GE-3: Fundamentals of Electrical Circuits
    b. DSE-2/ GE-4: Electro-Mechanical Energy Conversion

2. **Minor/Specialization in Robotics and Automation (Offered to EE, ECE, and CSE)**
    a. DSE-1/ GE-3: Fundamentals of Signal and Systems
    b. DSE-2/ GE-4: Sensors & Transducers

3. **Minor/Specialization in Sustainable Energy Engineering (Offered to EE, ECE, and CSE)**
    a. DSE-1/ GE-3: Energy and Its Resources
    b. DSE-2/ GE-4: Design and Evaluation of Photovoltaic Power Plants

4. **Minor/Specialization in Electric and Hybrid Vehicle (Offered to EE, ECE, and CSE)**
    a. DSE-1/ GE-3: Introduction to Electric and Hybrid Vehicles
    b. DSE-2/ GE-4: Electric Vehicle Motor

Detailed Syllabus of Generic Elective (GE) courses offered for Minors / Specializations by Department of Electrical Engineering in SEMESTER III

Fundamentals of Electrical Circuits (DSE-1/ GE-3)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Electrical Circuits	4	3	0	1	Introduction to Electrical and Electronics Engineering, Mathematics I.

Course Hours: L-03, T-00, P-02

Course Objectives:

1. To solve different complex circuits using various network reduction techniques such as Source Transformation, Network theorems etc.
2. To understand basic concepts of DC and AC circuit behavior.
3. To analyze the transient response of series and parallel A.C. circuits and to solve problems in time domain using Laplace Transform.
4. To analyze two port circuit behaviors.

Course Outcomes:

1. At the end of this course, students will demonstrate the ability to:
2. Acquire and demonstrate the knowledge of circuit elements, different laws and resonating behavior of circuits.
3. Apply the knowledge of basic circuit law to simplify the networks using network theorems.
4. Analyze the RL, RC and RLC circuits using Laplace transform.
5. Analyze the transient, steady state of RL, RC and RLC circuits for AC and DC excitations.
6. Analysis of various two port networks with their connection, interrelationships and interconnection of two port networks (with respect to impedance, admittance, hybrid and transmission parameters).

UNIT-I

Introduction to AC circuits: Review of AC Circuits and Introduction to three phase circuits, Series and parallel resonance, frequency response of series and Parallel circuits, Q–Factor, Bandwidth.

Magnetically coupled circuits: Dot convention, Self and Mutual Inductance, Energy in a coupled circuit.

UNIT-II

Network Theorems for AC & DC circuits: Node and Mesh analysis, Thevenin's & Norton's Theorems, Superposition Theorem, Reciprocity, Compensation, Substitution, Maximum power transfer, Millman's and Tellegen's theorems. Examples with independent energy sources.

UNIT-III

Laplace Transforms and properties: Initial conditions in networks and network solution with Laplace transformation, step, ramp and impulse functions, initial and final value theorem.

Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations.

UNIT-IV

Two port networks: Network & Transfer functions for one port & two ports, poles and zeros, Necessary condition for driving point & transfer function. Two port parameters – Z, Y, ABCD, Hybrid parameters, their inverse & image parameters, relationship between parameters, Interconnection of two ports networks, Terminated two port networks.

Suggestive Readings:

1. Lawrence P. Huelsman, Basic Circuit Theory, Prentice Hall India Learning Private Limited; 3rd edition.
2. William H. Hayt, Jack Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill Education; Eighth edition (4 August 2013).
3. Raymond A. DeCarlo, Pen-Min Lin , Linear Circuit Analysis, OUP USA; 2nd edition.
4. M.E. Van Valkenburg, Network Analysis, Phi Learning, 3rd Edition, 2010.
5. William D Stanley: Network Analysis with Applications, Pearson Education, 4th Edition, 2013.

List of Experiments:

1. To verify the Thevenin's Theorem.
2. To verify the Superposition Theorem.
3. To verify the Maximum Power Transfer Theorem.
4. To verify Reciprocity Theorem.
5. To verify the Millman's Theorem.
6. To verify the Tellegan's Theorem.
7. To construct RL & RC transient circuits and to draw the transient curves.
8. To obtain the resonance frequency of the given RLC series electrical network.
9. To determine open circuit parameters and short circuit parameter of the given two-port network.
10. To calculate and verify 'ABCD' parameters of a two-port network.
11. To calculate and verify Hybrid parameters of two-port network.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Fundamentals of Signal and Systems (DSE-1/ GE-3)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Signal and Systems	4	3	1	0	Introduction to Electrical and Electronics Engineering, Mathematics-I

Course Hours: L-03, T-01, P-00

Course Objectives:

1. To understand the categories of signals and systems.
2. To learn the different applications of transforms in signals.
3. To understand the sampling and its applications.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Apply the various mathematical operations on different signals and systems.
2. Apply the various transforms such as Fourier series, Fourier transforms, Laplace transforms and z-transforms in signals.
3. Understand sampling which will also help understand other introductory courses.

UNIT-I

Introduction to various types of signals and systems

Types of signals, energy and power of signals, periodic-aperiodic signals, even-odd signals and standard signals. Mathematical operations on signals, different systems and its properties.

UNIT-II

System response and Fourier Transforms

Convolution integral and convolution sum, Impulse response, difference equation. Fourier series representation of continuous and discrete time periodic signals, convergence, properties of Fourier series, Application of Fourier series in filtering, Fourier transform representation of continuous and discrete time signals, Fourier transform properties.

UNIT-III

Properties of Laplace and Z-Transform

The Laplace transform, region of convergence, properties of Laplace transform, inverse Laplace transform, system functions, poles and zeros of system functions, analysis and characterization of LTI systems using Laplace transform, z-transform, region of convergence and pole-zero plot for z-transform, properties of z-transform.

UNIT-IV

Sampling Theorem and A/D conversion

Sampling Theorem, classification of sampling, aliasing, anti-aliasing filter, analog to digital conversion, signal reconstruction.

Suggestive Readings:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, “Signals and Systems”, Prentice Hall, 2nd Edition.
2. S. Haykin and B. Van Been, “Signals and Systems”, John Wiley & Sons, 2nd Edition, 2003.
3. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2nd edition, 2006.

Energy and Its Resources (DSE-1/ GE-3)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Energy and Its Resources	4	3	0	1	Nil

Course Hours: L-03, T-00, P-02

Course Objectives:
Examine diverse energy sources and their environmental impact. Analyze energy conversion processes. Understand policy frameworks and global trends. Foster critical thinking for sustainable energy use and resource management.

Course Outcomes:

1. Understanding of energy units, unit conversion, unit magnitudes
2. Understanding energy needs of self, institution, country and world, energy consumption by sector
3. Wind, biomass and solar energy resources
4. Per capita energy consumption and impact on social and economic parameters 5. Future scenarios of energy requirements.

UNIT-I

Energy and its units: discussion on role of energy in our lives, various sources of energy that we use, units of energy, small and large units of energy, magnitude of energy units, units for energy consumption of individual, institution and country.
Renewable and Non-renewable energy: difference, characteristics of resources, advantages and disadvantages, discussion in class on which type of resources to be used by individual, by a country, reason out why?

UNIT-II

Energy requirements of a country: evolution of energy consumption, population of country, number of demands for energy, per demand energy, estimating energy consumption of country, discussion on possible growth on energy demand, should it grow or not?
World energy scenario- consumption: energy consumption of world, by resources, by sector, per capita electricity and total energy consumption, comparison among countries and between continents, relationship between Human Development Index (HDI) and energy consumption, discussion in the class on disparity in energy consumption.

UNIT-III

India's energy scenario: India's energy consumption from all resources, consumption of oil, coal, gas, import of fossil resources, foreign exchange requirements, discussion on energy security of country and imports dependency. Renewable energy sources: what are renewable energy sources? Why they are renewable? summary of all RE resources, global scenario of these resources.

UNIT-IV

Wind and Biomass resources in India: discussion on origin of these resources, potential of these resources in India, how these resources are converted into useful energy.

Solar energy resources: Sun as source of energy, solar energy reaching the Earth's surface, solar spectrum, photons of different energy, solar irradiation and solar radiation/insolation, extra-terrestrial solar radiation, global, direct and diffuse solar radiation.

Suggestive Readings:

1. S. P. Sukhatme and J. K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw Hill, 2008.
2. Solar Photovoltaics – Fundamentals, Technologies and Applications, 3rd Ed. Prentice Hall of India, 2016.
3. John Twidell, Tony Weir, Renewable Energy Resources, Taylor & Francis, 2005
4. Andrew L. Simon, Energy Resources, Elsevier Science, 2013.
5. World Energy report (https://www.iea.org/reports/)
6. Knowledge Centre, Ministry of New & Renewable Energy - Government of India (https://mnre.gov.in/)

List of Experiments:

1. Measure instantaneous solar irradiation (W/m^2) inside a classroom and under a clear sunny sky and compare.
2. Measure the short circuit current of solar panel under various orientation of solar panel with respect to the Sun. Note down reading, compare the variation in measured current values and compare and comment on variation in the values.
3. Measure energy consumption of a light and a fan (or any other appliance) in your lab using power meter / energy meter over the duration of experiment. Also do the theoretical estimation of possible energy consumption by the appliances over the same time. Compare both and comments.
4. Figure out from which point electricity is entering your campus/building, how it is being measured, check if you can take any reading, discuss the electrical supervisor on daily, monthly electricity consumption of the campus, discuss the variation of electricity consumption with season and reason behind it.
5. Debate on which energy sources to be promoted, students are to be divided in 4 or 5 groups, each group representing different source, each group presents their idea why that particular source should be promoted, the task of the whole class is to come to a conclusion on use of a particular source.
6. Estimate the monthly energy consumption of your own family, include energy consumption from electricity, petrol, diesel, LPG, public transportation, etc. Make a brief report on it.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Introduction to Electric and Hybrid Vehicles (DSE-1/ GE-3)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to Electric and Hybrid Vehicles	4	3	1	0	Introduction to Electrical and Electronics Engineering, Physics

Course Hours: L-03, T-01, P-00

Course Objectives:

1. To understand the concept of electric vehicles.
2. To study about the motors & drives for electric vehicles.
3. To understand the concept of hybrid vehicles.

Course Outcomes:

At the end of this course, students will be able to:

1. Describe about working principle of electric vehicles.
2. Explain the construction and working principle of various motors used in electric vehicles.
3. Understand about working principle of electronics and sensor less control in electric vehicles.
4. Describe the different types and working principle of hybrid vehicles.

UNIT-I

Introduction to Electric Vehicles

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor,
Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

UNIT-II

Electronics and Sensor-less control in EV

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Selfdrive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance- Based, Modulated Signal Injection, Mutually Induced VoltageBased, Observer-Based.

UNIT-III

Hybrid Vehicles

Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series,Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy,
Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

UNIT-IV

Advancement in E-vehicles

Integration of IoT in e-vehicle, Wireless sensor networks need for IoT, Intelligent Transport Systems, Degradation and disposal of batteries, modes of fast and efficient charging, and availability of charging stations as per Indian road conditions. Types of standards. Safety rules and regulations.

Suggestive Readings:

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007
3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid
4. Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.
5. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
6. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.
7. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
8. Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.
9. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

Detailed Syllabus of Generic Elective (GE) courses offered for Minors / Specializations by Department of Electrical Engineering in SEMESTER IV

Electro-Mechanical Energy Conversion (DSE-2/ GE-4)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electro-Mechanical Energy Conversion	4	3	1	0	Introduction to Electrical and Electronics Engineering, Fundamentals of Electrical Circuits

Course Hours: L-03, T-01, P-00

Course Objectives:
To make the students familiar with the fundamentals of various type of transformers, DC machines, Induction Machines and Synchronous Machines which are important entities in the field of Electrical Engineering.

Course Outcomes:

At the end of this course, students will be able to:

1. Understand the constructional features and operating principles of transformers, both single phase and three-phase and to determine the voltage regulation and performance characteristics of transformers.
2. Understand the intricate details of the construction of DC machines, needed in the design and fabrication of DC generators. Knowledge of the armature winding will enable the students to perform fault finding in the armature.
3. Review the constructional details of three-phase induction motors and understand their working principles, analyze the equivalent circuit, interpret the power flow diagram, phasor diagram and evaluate the characteristics.
4. Analyze the constructional features of polyphase synchronous machines and explain their operating principles, excitation systems. Derive the EMF equation, equivalent circuit model, and phasor diagram for cylindrical rotor and salient pole of synchronous machines and apply the two-reaction theory of salient pole synchronous machines.

UNIT-I

Transformers: Constructional review of single-phase transformer, Equivalent circuits, voltage regulation, short circuit and open circuit tests, Autotransformers, All day efficiency.

UNIT-II

D.C. Machines: Review of constructional features, Methods of excitation, Voltage and torque equations, Operation as generator, characteristics, Armature reaction, Commutation. Operation as a Motor, characteristics. Starter, speed control, Losses and Efficiency.

UNIT-III

Three Phase Induction Machines: Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque, Equivalent circuit, Phasor Diagram, Losses and

Efficiency, Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency).

UNIT-IV

Synchronous Machines: Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation, Operating characteristics of synchronous machines, V-curves.

Suggestive Readings:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2011.

Sensors and Transducers (DSE-2/ GE-4)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Sensors and Transducers	4	3	0	1	Fundamentals of Signal and Systems

Course Hours: L-03, T-00, P-02

Course Objectives:
To provide students the fundamentals of sensor and transducers used for different sensing system systems. In depth knowledge of different types of sensors with their applications and data acquisition and signal processing.

Course Outcomes:
At the end of this course, students will demonstrate the ability to:

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light.
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors
5. Locate different type of sensors used in real life applications and paraphrase their importance.
6. Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers and develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.

UNIT-I

Mechanical and Electromechanical sensor: Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. Proximity Sensors.

Inductive sensor: Common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis.

UNIT-II

Capacitive sensors: Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics. Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.

Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics.

Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response.

Geiger counters, Scintillation detectors, Introduction to smart sensors.

UNIT-III

Thermal sensors: Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermistor material, shape, ranges and accuracy specification.

Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.

Radiation sensors: types, characteristics and comparison.

Pyroelectric type.

Transducers: Classifications, Transducers for measurement of nonelectrical quantities: displacement, level, strain, pressure, force, torque, temperature, flow, velocity, acceleration, speed, etc.; seismic measurements. Transducers for measuring Electrical quantities.

LVDT: Construction, material, output input relationship, I/O curve, discussion.

UNIT-IV

Signal Conditioners: Level shifters, voltage to current, current to voltage converter; Peak detectors, Sample/Hold circuit, linearizers.

Signal Processors: Window Comparators, Absolute value circuits, Precision rectifiers; Log- and Antilog- amplifiers – multiplier, divider, squarer, square rooter, RMS converter and True RMS circuits. F to V and V to F converters.

Data Acquisition System and Central monitoring: Single and multichannel data acquisition; Analog and digital display devices, Data loggers, Recorders, Plotters, Application of microprocessors in Instrumentation System.

Suggestive Readings:

1. Sensor & Transducers, D. Patranabis, 2nd edition, PHI Learning.
2. Instrument Transducers, H.K.P. Neubert, Oxford University press.
3. Measurement Systems: application & design, E.A.Doebelin, Mc Graw Hill.

List of Experiments:

1. Analysis of negative temperature co-efficient type thermistor sensor as a temperature sensor.
2. Experimentation on Load cell with signal conditioning.
3. Experiment on voltage and current measurement can be done in this Hall Effect transducer.
4. Experiments on different optical sensors like LDR/ photodiode/ photo transistor.
5. Experiment on the measurement of strain using Strain Gauge.
6. To study the characteristics of LVDT.
7. To study the characteristics of Crompton Potentiometer.
8. To study the characteristics of Piezo-electric transducer.
9. Measurement of displacement using inductive transducer.
10. Characteristics of capacitive displacement transducer.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Design and Evaluation of Photovoltaic Power Plants (DSE-2/ GE-4)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Design and Evaluation of Photovoltaic Power Plants	4	3	0	1	Energy and its resources

Course Hours: L-03, T-00, P-02

Course Objectives:
Develop expertise in designing photovoltaic power plants. Assess performance, economic viability, and environmental impact. Integrate technical and economic aspects. Foster skills for sustainable and efficient solar energy systems.

Course Outcomes:
1. Understand the solar power plant.
2. Able to model the Photovoltaic power plants.
3. Able to analyse the Photovoltaic power plants.
4. Able to design the Photovoltaic power plants.

UNIT-I
Introduction: Types of Solar Power Plant-Grid Connected solar Power Plant, Grid interactive solar power plant, Net Metering Solar Power Plant, Off-Grid /Hybrid solar power plant, Schemes of solar power plant. Selection of site and PV module technology.

UNIT-II
Modeling of Photovoltaic Power Plants, DC Side modeling (cells, modules, arrays, generation of module file), AC side modeling (inverters, transformers, grid connection).

UNIT-III
Algorithms for modeling solar irradiance, module temperature, shading, soiling, Structural aspects, contemporary issues, financial aspects.

UNIT-IV
Monitoring, Performance Assessment and Degradation, Real time monitoring and fault detection in large PV power plants, Performance Assessment of large PV Power Plants, Performance Degradation and Reliability of PV Power Plants

Suggestive Readings:

1. Sandia National Labs, PV Performance Modeling Collaborative, 2014 URL: https://pvpmc.sandia.gov/
2. Weidong Xiao, “Photovoltaic Power System: Modeling, Design, and Control”,Wiley, 2017.
3. Tamer Khatib, Wilfried Elmenreich, “Modeling of Photovoltaic Systems Using MATLAB: Simplified Green Codes”, Wiley, 2016
4. Luis Castaner, Santiago Silvestre, “Modelling Photovoltaic Systems Using PSpice”, Wiley, 2002.

List of Experiments:

1. Simulation study on Solar PV Energy system.
2. Obtain the VI-Characteristics of Solar PV system.
3. Effect Of Temperature Variation on Photovoltaic Array
4. Calculation of Efficiency of a stand-alone solar PV system.
5. Experiment on Shadowing effect & diode-based solution in Solar PV system.
6. Experiment on Performance assessment of Grid-connected and Standalone Solar Power System.
7. Simulation study on Hybrid (Solar-Wind) Power System.
8. Design of solar PV boost converter using P&O MPPT technique.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

Electric Vehicles Motors (DSE-2/ GE-4)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Electric Vehicles Motors	4	3	1	0	Introduction to Electric and Hybrid Vehicles

Course Hours: L-03, T-01, P-00

Course Objectives:
Understand principles, design, and operation of electric vehicle motors, focusing on efficiency, performance, and integration into EV systems.

Course Outcomes:
1. To understand the concept of electric vehicles motors.
2. To understand about the configuration of motors used in electric vehicles.
3. To understand the special electrical motors.

UNIT-I
CLASSIFICATIONS OF MOTORS
Introduction to EV motors – requirements - challenges - comparisons of EV motors and industrial motors - Motors (DC, Induction, BLDC, PMSM) – Types, Principle, Construction, Control - Electric Drive Train and its types.

UNIT-II
CONFIGURATION OF MOTORS
Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - configuration and control of Permanent Magnet Motor drives.

UNIT-III
AC MOTOR OPERATION CHARACTERISTICS
AC Induction Motor and Control - Basic Principle of AC Induction Motor Operation - Controls of AC Induction Motor - Selection and sizing of Motor - RPM and Torque calculation of motor - Motor Controllers.

UNIT-IV
SPECIAL ELECTRICAL MOTORS
Switched Reluctance Motor: Basic Magnetic Structure, Torque Production - SRM Drive Converter - Modes of Operation - Generating Mode of Operation (Regenerative Braking) - Sensorless Control - Phase Flux Linkage based Method.

Suggestive Readings:

1. Jack Erjavec and Jeff Arias, “Hybrid, Electric and Fuel Cell Vehicles”, Cengage Learning, 2012.
2. Jack Erjavec and Jeff Arias, “Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles”, Cengage Learning Pvt. Ltd., New Delhi, 2007

3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2009.
4. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
5. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.
6. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
7. Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.
8. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

SEMESTER III

Advance Electric Workshop-I (SEC)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Advance Electric Workshop-I	2	0	0	2	Electric Workshop

Course Hours: L-00, T-00, P-04

List of Jobs:

1. Transformer design & fabrication.
2. Battery Charger/eliminator.
3. Overhauling dc motor.
4. Overhanding Induction Motor 3-phase.
5. Overhauling Inductor Motor 1-phase.
6. Control panel for forward reverse / inching of IM.
7. Fabrication of contactor-controlled Star Della Starter (automatic).
8. Winding of single-phase IM.
9. Operation through programmable timer.

(Note: Course instructor may add/delete/update new experiments in addition to the above suggested practical exercise.)

SEMESTER IV

Pspice Modelling for Electrical Circuits (SEC)

(Credit Distribution and Pre-Requisites of the Course)

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Pspice Modelling for Electrical Circuits	2	0	0	2	Advanced Electrical Workshop-I

Course Hours: L-00, T-00, P-04

Practice of following:

Introduction to PSpice: Laying out a Schematic, Libraries, Moving Components, Display Properties, New Simulation, Main Operational Icons, Simulation Settings **Electric Circuit Analysis**: Basic Definitions and Terminology, Analysing methods, PSpice Examples, Transient Circuits and Laplace Transforms, Transfer Functions and System Parameters, PSpice Examples
AC Electric Circuit Analysis: AC Circuit Theory, Capacitors - Capacitive Reactance Plot, Capacitor Current and Voltage Waveforms Inductors - Inductor Signal Phase Measurement, AC Circuit Theorems, Thevenin's Theorem - Thevenin Impedance, Thevenin Voltage Norton Equivalent Circuit - The Output File, Exercises
Series and Parallel-tuned Resonance: Resonance, Series-Tuned Circuit, Current Response, Example, Parallel-Tuned LC R Circuit Universal Response Curue, Fourier series, Series-Tuned Circuit as a Low-Pass, Design Examples.
Semiconductor Devices and Characteristics: Semiconductor Devices, Diode Characteristics and Parameters, Zener Diode Characteristic, Silicon-Controlled Rectifier, Bipolar Transistor - Input and Output Characteristics, Junction Field-Effect Transistor - Input and Output Characteristics, D Operator, Exercises

Suggestive Readings:

1. Paul Tobin, PSpice for Circuit Theory and Electronic Devices, Morgan & Claypool Publishers, 2007.
2. Muhammad H. Rashid, Introduction to Pspice Using Orcad for Circuits and Electronics, Prentice-Hall of India h/t.Ltd, 2004.
3. Orcad Capture User's Guide, Cadence Design Systems, Second edition 2000.

Annexure-3

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Detailed Course Structure and Curriculum of B.Tech. (CSE) Second Year

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Course Structure of B.Tech. (CSE) Second Year
Semester – III

S.No.	Course	Course Title	Credits*			Total Credits
			L	T	P	
1.	DSC-7	Analysis and Design of Algorithms	3	0	1	4
2.	DSC-8	Digital System Design	3	0	1	4
3.	DSC-9	Database Management Systems	3	0	1	4
4.	DSE-1 or GE-3	Select a course from the specified list of DSE-1 or Select a course from the specified list of GE-3				4
5.	AEC	Select a course from the specified list of AECs				2
6.	SEC or IAPC	Choose one SEC or Internship/Apprenticeship/Project/Community Outreach (IAPC)				2
7.	VAC	Select a course from the specified list of VACs				2
Total Credits						22

Semester – IV

S.No.	Course	Course Title	Credits*			Total Credits
			L	T	P	
1.	DSC-10	Operating System	3	0	1	4
2.	DSC-11	Software Engineering	3	0	1	4
3.	DSC-12	Computer System Architecture	3	0	1	4
4.	DSE-2 or GE-4	Select a course from the specified list of DSE-2 or Select a course from the specified list of GE-4				4
5.	AEC	Select a course from the specified list of AECs				2
6.	SEC or IAPC	Choose one SEC or Internship/Apprenticeship/Project/Community Outreach (IAPC)				2
7.	VAC	Select a course from the specified list of VACs				2
Total Credits						22

**Credits*
L (01 Credit) is equivalent to 01 contact hour per week
T (01 Credit) is equivalent to 01 contact hour per week
P (01 Credit) is equivalent to 02 contact hours per week

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Pool of DSEs offered by the department in Second Year

S.No.	Semester	DSE	Paper Title
1.	III	DSE - 1	Object Oriented Programming
2.			Computational Statistics and Probability
3.			Front-end Web Design and Development
4.			Discrete Structures
5.	IV	DSE - 2	Foundations of Data Analysis
6.			Computer Graphics
7.			Introduction to IoT
8.			Optimization Techniques

List of SECs offered by the department in Second Year

S.No.	Semester	Paper Title
1.	III	Backend Development
2.	IV	App Development using Flutter

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Specializations and Minors offered by the department

Semester	GE	Minor (for ECE / EE)	Specializations / Minors (Open to CSE / ECE / EE)				
			Artificial Intelligence & Machine Learning	**Data Science**	**Software Engineering**	**Blockchain and Cybersecurity**	**Augmented Reality / Virtual Reality**
III	GE-3	Fundamentals of DBMS	Probability and Statistics for Computer Science	Probability and Statistics for Computer Science	Software Requirement Engineering	Fundamentals of Cybersecurity	Foundations of Augmented and Virtual Reality
IV	GE-4	Fundamentals of Operating System	Fundamentals of Data Analytics	Fundamentals of Data Analytics	Object Oriented Software Engineering	Cryptography Essentials	3D Graphics and Rendering

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Core (DSC) courses for B.Tech. (CSE) - Semester 3

ANALYSIS AND DESIGN OF ALGORITHMS (DSC-7)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Analysis and Design of Algorithms	4	3L	0T	1P	Data Structures

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will:

1. Develop the ability to analyze the running time and prove the correctness of basic algorithms.
2. Be able to design efficient algorithms for moderately difficult computational problems, using various algorithm design techniques taught in the course.
3. Be able to prove the hardness of NP-Hard problems using simple reductions.
4. Be able to do performance analysis of simple approximation algorithms.

Course Objectives

1. Familiarize the student with some basic algorithms and their efficiency analysis.
2. Provide a detailed introduction to different algorithm design paradigms with illustrative problems.
3. Learn and implement dynamic programming and greedy algorithms.
4. Familiarize the student with graphs, computationally hard problems and tackling them using approximation algorithms.

Unit 1: Fundamentals of Algorithmic Problem Solving

Introduction to Algorithms and their Importance, Understanding the Role of Algorithms in Computing, Algorithmic Paradigms: Overview and Classification, Basic Analysis of Algorithms: Time and Space Complexity, Asymptotic Notations: Big O, Big Theta, Big Omega

Unit 2: Divide and Conquer Algorithms

Principles of Divide and Conquer, Classic Examples: Binary Search, Merge Sort, Quick Sort, Analysis of Divide and Conquer Algorithms, Application in Multiplication of Large Integers and Matrix Multiplication, Master Theorem for Divide and Conquer Recurrences

Unit 3: Dynamic Programming and Greedy Algorithms

Introduction to Dynamic Programming, Key Principles and Comparison with Divide and Conquer, Examples: Fibonacci Series, Longest Common Subsequence, Knapsack Problem etc, Greedy Algorithm Fundamentals, Greedy Algorithm Examples: Activity Selection, Kruskal's and Prim's Algorithms for MST etc

Unit 4: Graph Algorithms and Advanced Techniques

Graph Representation and Traversal: BFS and DFS, Shortest Path Algorithms: Dijkstra's, Bellman-Ford, Network Flow Problems: Ford-Fulkerson Method, Introduction to NP-Completeness and Intractable Problems, Approximation Algorithms for NP-Hard Problems

Suggested Readings

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. "Algorithm Design" by Jon Kleinberg and Éva Tardos
3. "The Algorithm Design Manual" by Steven S. Skiena
4. "Grokking Algorithms: An illustrated guide for programmers and other curious people" by Aditya Bhargava

Practical Component

1. Implementation of various algorithms in a high-level language
2. Case Studies: Analyzing real-world problems and designing algorithms
3. Comparative analysis of different algorithmic approaches for the same problem
4. Developing a mini-project using a combination of algorithmic techniques

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

DIGITAL SYSTEM DESIGN (DSC-8)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Digital System Design	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Develop a solid understanding of the fundamental principles and concepts of digital logic design, including Boolean algebra, logic gates, combinational and sequential circuits.
2. Gain the ability to design, analyze, and implement combinational and sequential logic circuits using both theoretical methods and hardware description languages (HDLs) such as VHDL and Verilog.
3. Achieve proficiency in using hardware description languages (HDLs) for modeling, simulating, and synthesizing digital systems.

Course Objectives

1. Understand the principles of digital logic design.
2. Learn to design, analyze, and implement combinational and sequential logic circuits.
3. Gain proficiency in using hardware description languages for digital system design.
4. Develop skills in designing and testing digital systems.

Unit 1: Fundamentals of Digital Logic

Introduction to Digital Systems: Digital vs. Analog systems, Binary numbers and arithmetic, Logic gates and their characteristics, Boolean Algebra and Logic Simplification: Boolean algebra principles, DeMorgan's Theorems, Simplification of Boolean expressions using algebraic methods, Combinational Logic Design: Design and analysis of combinational circuits, Karnaugh maps for simplification, Implementation using logic gates, Standard Combinational Modules: Multiplexers and demultiplexers, Encoders and decoders, Comparators and adders.

Unit 2: Sequential Logic Design

Differences between combinational and sequential circuits, Flip-flops: SR, D, JK, and T flip-flops, Design and Analysis of Sequential Circuits: State diagrams and state tables, Design of counters and registers, Analysis and design of synchronous sequential circuits.

Unit 3: Hardware Description Languages

Overview of VHDL and Verilog, Syntax and semantics of HDLs, Writing simple HDL programs, Combinational Logic Design using HDLs, Sequential Logic Design using HDLs.

Unit 4: Advanced Digital System Design

Design of Arithmetic Circuits: Binary arithmetic: addition, subtraction, multiplication, and division, Design of ALUs (Arithmetic Logic Units), Floating-point arithmetic circuits, Data Path and Control Path Design: Design of data paths, Control path design methodologies, Integration of data path and control path, Digital System Design Flow: Overview

of the design flow from specification to implementation, Design verification and validation, Case studies of digital system design projects

Suggested Readings

1. "Digital Design" by M. Morris Mano and Michael D. Ciletti
2. "Fundamentals of Logic Design" by Charles H. Roth Jr. and Larry L. Kinney
3. "Modern Digital Electronics" by R. P. Jain (TMH)
4. "Digital Principles and Application" by Malvino & Leach (TMH)

Practical Component

1. Develop proficiency in using VHDL/Verilog for digital system design.
2. Design, simulate, and implement basic logic gates (AND, OR, NOT, NAND, NOR, XOR) using hardware description languages (VHDL/Verilog)
3. Design and implement combinational circuits such as adders, multiplexers, and decoders using HDLs.
4. Design and implement sequential circuits such as flip-flops, counters, and shift registers using HDLs.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

DATABASE MANAGEMENT SYSTEMS (DSC-9)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Database Management Systems	4	3L	0T	1P	Data Structures

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Define program-data independence, data models for database systems, database schema and database instances.
2. Recall Relational Algebra concepts, and use it to translate queries to Relational Algebra.
3. Identify Structure Query Language statements used in creation and manipulation of database.
4. Identify the methodology of conceptual modeling through the Entity Relationship model.
5. Identify the methodology of the logical model and also identify the methodology of the physical model.
6. Analyze and design a real database application and develop and evaluate a real database application using a database management system.

Course Objectives

1. Provide an introduction to relational database systems.
2. Familiarize the student with the relational model, SQL, transactions, database design, and advanced concepts such as NoSQL, data warehousing, data mining, and distributed databases.

Unit 1: Introduction to DBMS

Overview of Database Systems, Database System Architecture, Data Models: Hierarchical, Network, Relational, Object-oriented, Data Independence, Database Languages and Interfaces

Unit 2: Data Modeling

Entity-Relationship Model: Entities, Attributes, Relationships, Enhanced E-R Model, Conversion of ER Model to Relational Model, Normalization: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF, Denormalization Techniques

Unit 3: SQL and Database Design

SQL: DDL, DML, DCL, Advanced SQL: Joins, Subqueries, Views, Indexes, Stored Procedures and Triggers, Transaction Management: ACID Properties, Concurrency Control, Database Security and Authorization

Unit 4: Advanced Topics

NoSQL Databases: Key-Value, Document, Column-Family, Graph, Data Warehousing and Data Mining, Distributed Databases and Object-Oriented Databases, Big Data Technologies and Trends, Database Backup and Recovery

Suggested Readings

1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, S. Sudarshan

2. "Fundamentals of Database Systems" by Ramez Elmasri, Shamkant B. Navathe
3. "SQL: The Complete Reference" by James Groff , Paul Weinberg, Andy Oppel
4. "Expert MySQL" by Charles Bell

Practical Component

1. Design and implement a database for a real-world application
2. SQL query writing, optimization, and performance tuning
3. Implementing a NoSQL database solution

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Detailed Syllabus of Discipline Specific Elective (DSE) Courses for B.Tech. (CSE) - Semester 3

OBJECT-ORIENTED PROGRAMMING (DSE-1)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Object-Oriented Programming	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand and apply basic OOP concepts.
2. Implement advanced OOP concepts such as abstract classes, interfaces, exception handling, generic programming, inner classes, lambda expressions, reflection, and annotations in software development projects.
3. Apply creational, structural, and behavioral design patterns in real-world software development scenarios.
4. Use OOP principles to design and develop small to medium-scale software projects.

Course Objectives

1. Provide students with a thorough understanding of the basic principles of object-oriented programming, including classes, objects, inheritance, polymorphism, encapsulation, and the use of constructors and destructors.
2. Equip students with advanced OOP concepts such as abstract classes, interfaces, exception handling, generic programming, inner classes, lambda expressions, reflection, and annotations.
3. Introduce students to various design patterns, their real-world applications, and the impact of anti-patterns, emphasizing creational, structural, and behavioral patterns.
4. Enable students to apply OOP principles in software engineering using languages such as Java and C++, exploring advanced features and best practices, and analyzing case studies of large-scale OOP-based software systems.

Unit 1: OOP Concepts

Fundamentals of OOP: Classes, Objects, Methods, Inheritance: Single, Multiple, Multilevel, Hierarchical, Polymorphism: Compile-time and Runtime, Encapsulation and Data Hiding, Constructors and Destructors.

Unit 2: Advanced OOP Concepts

Abstract Classes and Interfaces, Exception Handling and Assertions, Generic Programming, Inner Classes and Lambda Expressions, Reflection and Annotations.

Unit 3: Design Patterns

Creational Patterns: Singleton, Factory, Builder, Prototype, Structural Patterns: Adapter, Composite, Proxy, Flyweight, Behavioral Patterns: Strategy, Command, Observer, Iterator, Real-world applications of design patterns, Anti-patterns and their impact.

Unit 4: OOP in Software Development

OOP principles in software engineering, OOP in Java: Advanced features and libraries, OOP in C++: STL, Templates, Operator Overloading, Case studies: OOP in large-scale software systems, Best practices in OOP

Suggested Readings

1. "Object-Oriented Analysis and Design with Applications" by Grady Booch, Robert A. Maksimchuk, Michael W. Engle
2. "Design Patterns: Elements of Reusable Object-Oriented Software" by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

Practical Component

1. Development of small to medium scale OOP projects
2. Implementation of various design patterns in projects
3. Object-oriented analysis and design exercises
4. Case studies: Analyzing OOP-based software

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

COMPUTATIONAL STATISTICS AND PROBABILITY (DSE-1)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Computational Statistics and Probability	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand and apply probability theory.
2. Analyze random variables and distributions.
3. Execute point and interval estimation, perform linear and multiple regression analysis, conduct ANOVA and non-parametric tests, and analyze time series data for forecasting purposes.
4. Apply Monte Carlo methods and simulations, understand and use queueing theory (M/M/1, M/M/c), model decision processes using Markov chains, analyze system reliability and survival, and utilize statistical learning and data mining techniques.

Course Objectives

1. Provide students with a thorough understanding of the basic concepts of probability, including conditional probability, random variables, and key probability distributions, along with expectations and moment generating functions.
2. Equip students with knowledge of joint, marginal, and conditional distributions, functions of random variables, the Central Limit Theorem, sampling distributions, and hypothesis testing methods.
3. Enable students to perform point and interval estimation, regression analysis, ANOVA, non-parametric tests, and time series analysis, and to understand their applications in data analysis.
4. Familiarize students with practical applications of computational statistics in computer science, including Monte Carlo simulations, queueing theory, Markov chains, reliability theory, and statistical learning.

Unit 1: Probability Theory

Basic concepts of probability, Conditional probability and Bayes' theorem, Discrete and continuous random variables, Probability distributions: Binomial, Poisson, Normal, Expectation, Variance, and Moment generating functions.

Unit 2: Random Variables and Distributions

Joint, Marginal, and Conditional distributions, Functions of random variables, Central Limit Theorem and its implications, Sampling distributions and estimators, Hypothesis testing: Z-test, T-test, Chi-square test.

Unit 3: Statistical Methods

Point and Interval estimation, Regression analysis: Linear and Multiple regression, Analysis of Variance (ANOVA), Non-parametric tests, Time series analysis and forecasting.

Unit 4: Applications in Computer Science

Monte Carlo methods and simulations, Queueing theory: M/M/1, M/M/c queues, Markov chains and decision processes, Reliability theory and survival analysis, Statistical learning and data mining.

Suggested Readings

1. "Probability and Statistics for Engineering and the Sciences" by Jay L. Devore
2. "Introduction to Probability and Statistics for Engineers and Scientists" by Sheldon M. Ross
3. "Probability, Random Variables, and Stochastic Processes" by S. U. Papoulis, A. Pillai

Practical Component

1. Statistical analysis using R or Python
2. Data visualization techniques
3. Simulations for probabilistic models
4. Case studies: Application of statistics in computer science

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

FRONT-END WEB DESIGN AND DEVELOPMENT (DSE-1)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Front-end Web Design and Development	4	0L	0T	4P	-

Course Hours: L: 00 T: 00 P: 04

Course Outcomes

At the end of this course, students will be able to:

1. Create and style web pages using HTML and CSS.
2. Develop interactive web pages using JavaScript.
3. Apply responsive design principles using media queries and responsive frameworks. Develop mobile-first designs, ensure accessibility and adherence to web standards, and achieve cross-browser compatibility.
4. Build applications using front-end frameworks and libraries.

Course Objectives

1. Provide students with a comprehensive understanding of HTML5 and CSS3, covering essential elements, attributes, semantic HTML, selectors, the box model, and layout techniques including Flexbox and Grid Layout. Additionally, introduce responsive web design principles and CSS preprocessors like SASS and LESS.
2. Equip students with the basics of JavaScript, including syntax, variables, and data types, as well as advanced concepts like ES6 features. Enable students to manipulate the DOM, handle events, and make asynchronous web requests using AJAX and the Fetch API.
3. Teach students the principles of responsive web design, including media queries and responsive frameworks, the mobile-first design approach, accessibility standards, and cross-browser compatibility.
4. Familiarize students with popular front-end frameworks and libraries, including React.js, Vue.js, and Angular. Teach the basics of building single-page applications (SPAs) and utilizing UI design frameworks like Bootstrap.

Unit 1: HTML and CSS

HTML5: Elements, Attributes, Semantic HTML, CSS3: Selectors, Box Model, Flexbox, Grid Layout, Responsive Web Design Principles, CSS Preprocessors: SASS, LESS.

Unit 2: JavaScript and DOM Manipulation

JavaScript Basics: Syntax, Variables, Data Types, DOM Manipulation: Selectors, Events, Event Listeners, ES6 Features: Arrow Functions, Promises, Modules, AJAX and Fetch API for Asynchronous Web Requests.

Unit 3: Responsive Design

Media Queries and Responsive Frameworks, Mobile-First Design Approach, Accessibility and Web Standards, Cross-Browser Compatibility.

Unit 4: Frameworks and Libraries

Introduction to React.js: Components, State, Props, Working with Bootstrap for UI Design, Introduction to Vue.js and Angular, Building Single Page Applications (SPAs).

Suggested Readings

1. "HTML and CSS: Design and Build Websites" by Jon Duckett
2. "Eloquent JavaScript: A Modern Introduction to Programming" by Marijn Haverbeke
3. "Learning React: A Hands-On Guide to Building Web Applications Using React and Redux" by Kirupa Chinnathambi

Practical Component

1. Designing and developing a responsive website
2. Implementing interactive features using JavaScript and frameworks
3. Project: Develop a complete front-end for a web application

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

DISCRETE STRUCTURES (DSE-1)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Discrete Structures	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand and apply concepts of sets, relations, and functions.
2. Apply basic counting techniques in combinatorial problems, understand and work with different types of graphs and their representations, perform graph traversals, and analyze properties of trees and planar graphs. Utilize graph coloring techniques and network models in practical scenarios.
3. Understand and apply the properties of groups, subgroups, rings, and fields. Work with polynomials and understand their applications. Analyze and utilize lattices and Boolean algebra in various contexts.
4. Analyze and construct propositional and predicate logic statements, use logical connectives and truth tables to determine tautologies and contradictions, understand logical equivalence and normal forms. Simplify Boolean functions and apply them in digital logic design.
5. Participate in hands-on exercises and projects that involve set theory, combinatorics, graph theory, algebraic structures, and logic.

Course Objectives

1. Provide students with a comprehensive understanding of set theory, relations, and functions, including their definitions, properties, and operations.
2. Equip students with basic counting techniques and the fundamentals of graph theory, including graph types, representations, traversals, trees, planar graphs, graph coloring, and network models.
3. Introduce students to algebraic structures such as groups, rings, and fields, along with their properties and applications.
4. Familiarize students with propositional and predicate logic, logical connectives, truth tables, tautologies, contradictions, logical equivalence, and normal forms.

Unit 1: Sets, Relations, and Functions

Set Theory: Definitions, Operations, Venn Diagrams, Relations: Types, Properties, Closure, Functions: Types, Composition, Inverse, Counting: Pigeonhole Principle, Permutations and Combinations, Mathematical Induction and Recursion.

Unit 2: Combinatorics and Graph Theory

Basic Counting Techniques, Graphs: Types, Representations, Traversals, Trees: Properties, Binary Trees, Tree Traversals, Planar Graphs, Graph Coloring, Network Models and Algorithms.

Unit 3: Algebraic Structures

Groups: Definitions, Properties, Subgroups, Rings and Fields: Definitions, Properties, Polynomials and their Applications, Lattices and Boolean Algebra.

Unit 4: Logic and Boolean Algebra

Propositional and Predicate Logic, Logical Connectives, Truth Tables, Tautologies, and Contradictions, Logical Equivalence, Normal Forms, Boolean Functions, Simplification of Boolean Functions, Applications in Digital Logic Design.

Suggested Readings

1. "Discrete Mathematics and Its Applications" by Kenneth H. Rosen
2. "Concrete Mathematics: A Foundation for Computer Science" by Ronald L. Graham, Donald E. Knuth, and Oren Patashnik

Practical Component

1. Problem-solving sessions using combinatorial techniques
2. Implementing graph algorithms
3. Boolean function simplification using software tools

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Core (DSC) courses for B.Tech. (CSE) - Semester 4

OPERATING SYSTEM (DSC-10)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Operating System	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will:

1. Develop an understanding of how an operating system functions as a middle layer between the hardware of a computer and the user.
2. Appreciate the design issues and concepts underlying some of the well known operating systems.
3. Compare the pros and cons of various design options and various issues involved in the design of a large software.
4. Understand the concepts of process management, memory management, and file systems.

Course Objectives

1. Introduce the student to the basic concepts involved in the design and implementation of an operating system.
2. Familiarize the student with important modules of operating systems like process management, memory management, file systems, synchronization primitives and exception handling.

Unit 1: Introduction to Operating Systems

Overview of Operating Systems, OS structure: Monolithic, Microkernel, Layered, Modular, System calls and System programs, Bootstrapping and BIOS, OS services and User Interface.

Unit 2: Process Management

Process Concept, Process Scheduling, Inter-process communication (IPC), Threads and Concurrency, Deadlocks: Detection, Prevention, Avoidance, Synchronization mechanisms: Semaphores, Monitors.

Unit 3: Memory Management

Memory hierarchy, RAM vs Cache, Paging, Segmentation, and their combination, Virtual Memory: Demand Paging, Page Replacement Algorithms, Memory Allocation strategies, Memory Protection and Sharing.

Unit 4: File Systems and Security

File concepts, Access methods, Directory structure, File system mounting, File sharing, Protection, Disk scheduling algorithms, Security: Authentication, Encryption, Firewalls, Case studies: UNIX/Linux, Windows OS

Suggested Readings

1. "Operating System Concepts" by Abraham Silberschatz, Peter B. Galvin, Greg Gagne
2. "Modern Operating Systems" by Andrew S. Tanenbaum, Herbert Bos

Practical Component

1. Simulation of OS components (Scheduler, Memory Management)
2. Shell scripting and System programming
3. Development of simple synchronization problems
4. Case studies: Comparative OS analysis

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

SOFTWARE ENGINEERING (DSC-11)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Software Engineering	4	2L	0T	2P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

1. Students will be working in teams and by the end of the semester they will gain experience in handling various phases of software development. During the project, students will assume various participant roles like developer, project manager, architect etc, in addition to thinking and deciding on the design of various modules that constitute the software.
2. Students will learn to follow standard practices throughout the project and to stick to the specification of interfaces between different software modules so that a big software being developed by multiple persons can work together as required.

Course Objectives

1. Give students hands-on experience in designing and developing a reasonably big software - big enough that it warrants multiple phases (including architecture, design, and implementation) and multiple developers.
2. Promote collaboration and teamwork in students, with each team building a complete software product.
3. Expose the student to various phases of software development which includes requirements gathering and specification, systematic design using commonly seen design patterns, coding, component-wise testing, integration testing, version control, and software cost estimation.

Unit 1: Software Development Life Cycle

Overview of Software Engineering, Software Development Models: Waterfall, V-Model, Spiral, Agile methodologies: Scrum, Kanban, XP, Requirement Engineering: Elicitation, Analysis, Specification.

Unit 2: Software Design and Modeling

Software Design and Architecture, UML Diagrams: Use Case, Class, Sequence, State, Design Patterns: MVC, Singleton, Factory, Software Architecture: Layered, Client-Server, Microservices, API Design and Development.

Unit 3: Software Testing and Quality Assurance

Testing levels: Unit, Integration, System, Acceptance, Test Design Techniques: Black-box, White-box, Grey-box, Test Automation and Tools, Software Maintenance and Evolution, Software Metrics and Quality Attributes, Quality Assurance: Standards, ISO/IEC 9126.

Unit 4: Project Management

Project Planning and Estimation, Risk Management, Configuration Management, Software Project Management tools, Case studies: Successful and Failed Software Projects.

Suggested Readings

1. "Software Engineering" by K.K. Aggarwal, Yogesh Singh
2. "Software Engineering: A Practitioner's Approach" by Roger S. Pressman, Bruce Maxim
3. "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development" by Craig Larman

Practical Component

1. Software requirement and design exercises
2. Implementation of a small-scale software project
3. Software testing and debugging practices
4. Project management simulation

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

COMPUTER SYSTEM ARCHITECTURE (DSC-12)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Computer System Architecture	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. State the history and development of modern computer systems.
2. Interpret data representation and computer arithmetic.
3. Determine the key aspects of microarchitecture and instruction set architecture.
4. Estimate performance of computer systems and suggest methods for performance enhancement.
5. Specify the importance of memory hierarchy for efficient memory design and virtual memory to overcome memory wall.
6. Predict performance of IO subsystems.

Course Objectives

1. Familiarize the student with the basics of organizational and architectural issues of a digital computer.
2. Familiarize the student with performance issues in processor and memory design of a digital computer.
3. Make the student understand various data transfer techniques in digital computers.
4. Familiarize the student with processor performance improvement using instruction level parallelism.

Unit 1: Basics of Computer Architecture

Overview of computer architecture and organization, Von Neumann architecture and its limitations, Instruction set architecture, RISC vs CISC, Data representation: Binary, Hexadecimal, ASCII, Computer arithmetic: Integer and floating-point operations.

Unit 2: Data Representation and Processor Architecture

CPU architecture: ALU, Control Unit, Registers, Instruction cycle, Pipelining, Superscalar processors, Microprogramming and Control Unit design, Cache memory: Mapping techniques, Replacement policies, Virtual memory: Paging, Segmentation, TLB.

Unit 3: Memory Systems

Primary and Secondary memory, RAM technologies: SRAM, DRAM, SDRAM, ROM, PROM, EPROM, EEPROM, Memory hierarchy and optimization, RAID levels and their applications.

Unit 4: I/O Systems and Data Communication

I/O devices and their interfaces, Direct Memory Access (DMA), Buses: Types, Protocols, Bus arbitration, Serial and Parallel communication, Basics of computer networks and data transmission.

Suggested Readings

1. "Computer Organization and Design: The Hardware/Software Interface" by David A. Patterson and John L. Hennessy
2. "Computer Systems: A Programmer's Perspective" by Randal E. Bryant and David R. O'Hallaron

Practical Component

1. Simulation of CPU operations
2. Assembly language programming exercises
3. Design and simulation of simple processor circuits
4. Case studies on memory and I/O management

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Detailed Syllabus of Discipline Specific Elective (DSE) Courses for B.Tech. (CSE) - Semester 4

FOUNDATIONS OF DATA ANALYSIS (DSE-2)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Foundations of Data Analysis	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand the significance of Data Analytics.
2. Apply descriptive and inferential statistics.
3. Perform regression analysis (linear and logistic) and apply classification techniques.
4. Conduct time series analysis and forecasting, and understand the fundamentals of model validation and selection.
5. Participate in hands-on projects that involve data collection, cleaning, analysis, and interpretation.

Course Objectives

1. Provide students with a comprehensive understanding of data analytics, its importance across various domains, and the different types of data.
2. Equip students with knowledge of descriptive and inferential statistics, exploratory data analysis (EDA), and data visualization techniques.
3. Introduce students to the basics of predictive analytics, including regression analysis (linear and logistic), classification techniques, time series analysis, forecasting, and model validation and selection.
4. Provide hands-on experience with data analytics tools such as R and Python, and their libraries.

Unit 1: Introduction to Data Analytics

Overview of data analytics and its significance in various domains, Types of data: structured, unstructured, semi-structured, Data analytics lifecycle: data collection, cleaning, analysis, interpretation, Case studies demonstrating the impact of data analytics.

Unit 2: Data Analysis Techniques

Descriptive statistics: measures of central tendency and variability, Inferential statistics: hypothesis testing, confidence intervals, Introduction to exploratory data analysis (EDA), Data visualization techniques and tools.

Unit 3: Introduction to Predictive Analytics

Basics of regression analysis: linear and logistic regression, Overview of classification techniques, Time series analysis and forecasting basics, Introduction to model validation and selection.

Unit 4: Data Analytics Tools and Applications

Introduction to data analytics software: R, Python and its libraries, Data analytics in business decision-making, Ethical considerations in data analytics, Emerging trends in data analytics.

Suggested Readings

1. "Data Science for Business" by Foster Provost and Tom Fawcett
2. "Python for Data Analysis" by Wes McKinney
3. "Naked Statistics: Stripping the Dread from the Data" by Charles Wheelan

Practical Component

1. Performing exploratory data analysis using a dataset and presenting findings.
2. Implementing linear regression and logistic regression models on real-world data.
3. Creating data visualizations to interpret and communicate data insights.
4. Conducting a basic time series analysis project.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

COMPUTER GRAPHICS (DSE-2)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Computer Graphics	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand and apply foundational computer graphics concepts.
2. Create and manipulate 2D and basic 3D graphics.
3. Develop and render complex 3D models.
4. Conceptualize and develop a complex 3D scene, integrating advanced graphics techniques and user interactions.

Course Objectives

1. Provide students with a comprehensive understanding of the basic principles and applications of computer graphics, including graphics systems, hardware, coordinate systems, and transformations.
2. Equip students with knowledge and skills in basic drawing algorithms, 2D transformations, clipping and windowing techniques, color models, filling algorithms, and an introduction to 3D graphics including transformations and projections.
3. Enable students to create complex 3D models, apply texture mapping and material design, utilize lighting and shading models, implement hidden surface removal algorithms, and understand real-time rendering techniques including shader programming and GPU utilization.
4. Familiarize students with keyframe animation, motion capture, rigging, skeletal animation, facial animation, lip syncing, physics-based animation, and procedural animation techniques.

Unit 1: Foundations of Computer Graphics

Introduction to computer graphics and applications, Graphics systems and hardware, Coordinate systems and transformations, Introduction to OpenGL and graphics libraries.

Unit 2: 2D and Basic 3D Graphics

Basic drawing algorithms: lines, circles, and polygons, 2D transformations and animations, Clipping and windowing techniques, Color models and filling algorithms, Introduction to 3D graphics, 3D transformations and projections.

Unit 3: Advanced 3D Modeling and Rendering

Complex 3D Modeling Techniques, Texture Mapping and Material Design, Lighting and Shading Models, Hidden surface removal algorithms, Real-Time Rendering: Algorithms, Shader Programming, and GPU Utilization.

Unit 4: Animation, Rigging, and Advanced Techniques

Keyframe Animation and Motion Capture, Rigging and Skeletal Animation, Facial Animation and Lip Syncing, Physics-Based Animation and Procedural Animation Techniques, Advanced Graphics Project: Conceptualizing a Complex 3D Scene, Integrating Techniques, Implementing Interactions, and Project Presentation.

Suggested Readings

1. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, and Kurt Akeley
2. "Fundamentals of Computer Graphics" by Peter Shirley, Steve Marschner
3. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, Naty Hoffman

Practical Component

1. Implementing 2D and 3D transformations and animations.
2. Developing a simple 3D model and applying texture mapping.
3. Creating basic and advanced shaders for real-time rendering.
4. Conducting a project on complex 3D scene development.
5. Applying animation and rigging techniques to a 3D character.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

INTRODUCTION TO IOT (DSE-2)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Introduction to IoT	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a thorough understanding of the basic components of IoT, its communication models, and networking protocols.
2. Set up and configure IoT development boards like Raspberry Pi, Arduino, and ESP8266.
3. Apply various IoT connectivity technologies such as Wi-Fi, Bluetooth, Zigbee, and LoRa.
4. Understand the application of IoT in different domains including smart homes, industrial IoT, healthcare, and smart cities.

Course Objectives

1. Provide students with a comprehensive understanding of the basics of IoT.
2. Equip students with practical knowledge of IoT development boards, sensors, actuators, and programming languages.
3. Enable students to understand and apply various IoT connectivity technologies, data transmission methods, data protocols, and secure communication techniques.
4. Familiarize students with different applications of IoT in various domains such as smart homes, industrial IoT, healthcare, and smart cities.

Unit 1: IoT Fundamentals

Overview of IoT: Definition, History, and Applications, Basic Components of IoT: Sensors, Actuators, and Controllers, IoT Communication Models: Device-to-Device, Device-to-Cloud, and Device-to-Gateway, IoT Networking Protocols: MQTT, CoAP, HTTP, and WebSocket.

Unit 2: IoT Hardware and Software

Introduction to IoT Development Boards: Raspberry Pi, Arduino, ESP8266, etc., Setting up a basic IoT environment using Raspberry Pi/Arduino, Sensors and Actuators: Types and Use Cases, IoT Programming: Basics of Python and C/C++ for IoT, Interfacing Sensors with IoT Boards, Building IoT applications to collect and display sensor data.

Unit 3: IoT Communication and Networking

IoT Connectivity Technologies: Wi-Fi, Bluetooth, Zigbee, and LoRa, Data Transmission in IoT: Cloud Services and Data Storage, IoT Data Protocols: JSON, XML Secure Communication in IoT: Encryption and Authentication, Interfacing IoT systems with cloud.

Unit 4: IoT Applications and Case Studies

Smart Home and Building Automation, Industrial IoT (IIoT) and Smart Manufacturing, Healthcare and Wearable IoT Devices, Smart Cities and Infrastructure, Case studies of end-to-end IoT applications (e.g., smart home system, health monitoring device).

Suggested Readings

1. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj and Anupama C. Raman
3. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz

Practical Component

1. Weekly Lab Sessions: Hands-on experience with IoT development boards and sensors.
2. Mini Projects: Regular small projects to implement different IoT functionalities.
3. Final Project: A comprehensive project to design and develop a complete IoT system.
4. Case Study Analysis: Reviewing real-world IoT applications and their implementations.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

OPTIMIZATION TECHNIQUES (DSE-2)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Optimization Techniques	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a thorough understanding of optimization principles, types, and mathematical foundations.
2. Apply linear and non-linear programming techniques.
3. Solve discrete optimization problems using heuristic methods.
4. Utilize advanced optimization techniques in real-world applications.

Course Objectives

1. Provide students with a comprehensive understanding of the basics of optimization, including its definition, types, importance, and mathematical foundations.
2. Equip students with knowledge of linear and non-linear programming methods, including the Simplex method, duality, sensitivity analysis, gradient descent, Newton's method, and constrained optimization techniques.
3. Introduce students to discrete optimization techniques such as integer programming, branch and bound, cutting planes, and combinatorial optimization problems.

Unit 1: Introduction to Optimization

Basics of Optimization: Definition, Types, and Importance, Mathematical Foundations: Linear Algebra and Calculus Review, Formulating Optimization Problems: Objective Function, Constraints, Types of Optimization Problems: Linear, Non-linear, Integer, and Combinatorial, Solving basic optimization problems using Python (SciPy).

Unit 2: Linear and Non-Linear Programming

Linear Programming: Simplex Method, Duality, Sensitivity Analysis, Non-Linear Programming: Gradient Descent, Newton's Method, Constrained Optimization: Lagrange Multipliers, KKT Conditions, Implementation of linear and non-linear optimization algorithms using Python (SciPy, CVXPY).

Unit 3: Discrete Optimization and Heuristics

Integer Programming: Branch and Bound, Cutting Planes, Combinatorial Optimization: Traveling Salesman Problem, Knapsack Problem, Heuristic Methods: Genetic Algorithms, Simulated Annealing, Tabu Search, Solving discrete optimization problems using Python (PuLP, DEAP).

Unit 4: Advanced Optimization Techniques and Applications

Multi-Objective Optimization: Pareto Optimality, Weighted Sum Method, Metaheuristics: Particle Swarm Optimization, Ant Colony Optimization, Real-World Applications: Scheduling, Network Optimization, Machine Learning, Developing optimization solutions for real-world problems using Python and specialized libraries (e.g., PyGMO).

Suggested Readings

1. "Introduction to Operations Research" by Frederick S. Hillier and Gerald J. Lieberman
2. "Linear and Nonlinear Programming" by David G. Luenberger and Yinyu Ye
3. "Optimization in Operations Research" by Ronald L. Rardin
4. "Practical Optimization: Algorithms and Engineering Applications" by Andreas Antoniou and Wu-Sheng Lu

Practical Component

1. Hands-on practice with optimization algorithms and tools.
2. A small project to apply optimization techniques to various problems.
3. A comprehensive project to formulate and solve a complex optimization problem.
4. Reviewing and analyzing optimization problems in real-world scenarios.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

List of Discipline Specific Elective (DSE) / Generic Elective (GE) Courses offered for Minors / Specializations by department in Second Year

1. **Minor in CSE (Offered to ECE and EE)**
    a. DSE-1 / GE-3: Fundamentals of DBMS
    b. DSE-2 / GE-4: Fundamentals of Operating System

2. **Minor/Specialization in Artificial Intelligence & Machine Learning (Offered to CSE, ECE, and EE)**
    a. DSE-1 / GE-3: Probability and Statistics for Computer Science
    b. DSE-2 / GE-4: Fundamentals of Data Analytics

3. **Minor/Specialization in Data Science (Offered to CSE, ECE, and EE)**
    a. DSE-1 / GE-3: Probability and Statistics for Computer Science
    b. DSE-2 / GE-4: Fundamentals of Data Analytics

4. **Minor/Specialization in Software Engineering (Offered to CSE, ECE, and EE)**
    a. DSE-1 / GE-3: Software Requirement Engineering
    b. DSE-2 / GE-4: Object Oriented Software Engineering

5. **Minor/Specialization in Blockchain and Cybersecurity (Offered to CSE, ECE, and EE)**
    a. DSE-1 / GE-3: Fundamentals of Cybersecurity
    b. DSE-2 / GE-4: Cryptography Essentials

6. **Minor/Specialization in Augmented Reality / Virtual Reality (Offered to CSE, ECE, and EE)**
    a. DSE-1 / GE-3: Foundations of Augmented and Virtual Reality
    b. DSE-2 / GE-4: 3D Graphics and Rendering

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Elective (DSE) / Generic Elective (GE) courses offered for Minors / Specializations by the department in Semester 3

FUNDAMENTALS OF DBMS (DSE-1 / GE-3)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical		
Fundamentals of DBMS	4	2L	0T	2P	-	-

Course Hours: L: 03 T: 00 P: 02

Unit 1: Introduction to Database Systems

Evolution of database systems, Types of database systems: relational, NoSQL, NewSQL, Database system architecture and components, Data models: ER model, relational model

Unit 2: SQL and Database Design

Basics of SQL: DDL, DML, DCL, Normalization and denormalization: concepts and techniques, Database design process: from ER diagrams to relational schemas, Indexing, constraints, and triggers

Unit 3: Advanced Database Features

Stored procedures and views, Introduction to transaction management and concurrency control, Database security: authorization, authentication, encryption, Introduction to data warehousing and OLAP

Unit 4: NoSQL Databases and Big Data

Introduction to NoSQL databases: key-value, document, column-family, graph, Use cases for NoSQL databases and how they complement relational databases, Basics of big data technologies: Hadoop, Spark, Trends in database technologies

Suggested Readings

1. "Database System Concepts" by Abraham Silberschatz, Henry Korth, and S. Sudarshan
2. "SQL in 10 Minutes, Sams Teach Yourself" by Ben Forta
3. "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler

Practical Component

1. Designing and implementing a relational database schema based on a case study.
2. Writing SQL queries to manipulate and retrieve data.

3. Implementing a simple application using a NoSQL database.
4. Conducting a small-scale data warehousing project.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

PROBABILITY AND STATISTICS FOR COMPUTER SCIENCE (DSE-1 / GE-3)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Probability and Statistics for Computer Science	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a solid understanding of basic probability concepts, including conditional probability, Bayes' theorem, and various probability distributions (Binomial, Poisson, Normal), and calculate expectation and variance for different random variables.
2. Analyze and interpret statistical data using point and interval estimation, perform hypothesis testing (Z-test, T-test, Chi-square test), and understand the implications of the Central Limit Theorem and sampling distributions.
3. Apply regression analysis (linear and multiple), conduct ANOVA, and use non-parametric tests to draw meaningful inferences from data, along with performing time series analysis and forecasting.
4. Utilize statistical software tools (R or Python) for data analysis and visualization, perform simulations for probabilistic models, and critically evaluate case studies to understand the application of statistical methods in computer science.

Course Objectives

1. Impart a comprehensive understanding of the fundamental concepts in probability theory and statistics, including the ability to handle discrete and continuous random variables, and probability distributions.
2. Enable students to apply probability and statistical methods to analyze and solve problems in computer science, utilizing tools such as R or Python for statistical analysis and data visualization.
3. Train students in using statistical methods for hypothesis testing, regression analysis, and non-parametric tests, and to apply these techniques to real-world computer science applications such as queueing theory, Markov chains, and reliability analysis.
4. Expose students to advanced statistical applications in computer science, including Monte Carlo methods, time series analysis, statistical learning, and data mining, and to understand their practical implications through case studies and simulations.

Unit 1: Probability Theory

Basic concepts of probability, Conditional probability and Bayes' theorem, Discrete and continuous random variables, Probability distributions: Binomial, Poisson, Normal, Expectation, Variance, and Moment generating functions.

Unit 2: Random Variables and Distributions

Joint, Marginal, and Conditional distributions, Functions of random variables, Central Limit Theorem and its implications, Sampling distributions and estimators, Hypothesis testing: Z-test, T-test, Chi-square test

Unit 3: Statistical Methods

Point and Interval estimation, Regression analysis: Linear and Multiple regression, Analysis of Variance (ANOVA), Non-parametric tests, Time series analysis and forecasting

Unit 4: Applications in Computer Science

Monte Carlo methods and simulations, Queueing theory: M/M/1, M/M/c queues, Markov chains and decision processes, Reliability theory and survival analysis, Statistical learning and data mining

Suggested Readings

1. "Probability and Statistics for Engineering and the Sciences" by Jay L. Devore
2. "Introduction to Probability and Statistics for Engineers and Scientists" by Sheldon M. Ross

Practical Component

1. Statistical analysis using R or Python
2. Data visualization techniques
3. Simulations for probabilistic models
4. Case studies: Application of statistics in computer science

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

SOFTWARE REQUIREMENT ENGINEERING (DSE-1 / GE-3)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical		
Software Requirement Engineering	4	3L	0T	1P	-	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a comprehensive understanding of the requirements engineering process, including the elicitation, analysis, specification, and validation of functional, non-functional, system, and user requirements.
2. Conduct effective requirement elicitation using techniques such as interviews, surveys, use case scenarios, workshops, and prototyping, ensuring the accurate and complete gathering of requirements from stakeholders.
3. Utilize various modeling techniques (use case diagrams, activity diagrams, state diagrams) to analyze and specify software requirements, and prepare detailed and clear software requirement specification documents.
4. Apply validation techniques to ensure the accuracy and feasibility of gathered requirements, manage changes to requirements effectively, and maintain traceability throughout the software development lifecycle.

Course Objectives

1. Provide a thorough understanding of the significance of requirements engineering in the software development process, covering the essential stages of elicitation, analysis, specification, and validation of software requirements.
2. Equip students with practical knowledge and skills in various requirement elicitation techniques, such as interviews, surveys, workshops, and prototyping, ensuring comprehensive and accurate gathering of software requirements.
3. Enable students to model, analyze, and specify software requirements effectively, using tools and techniques like use case diagrams, activity diagrams, and state diagrams, and to prepare clear and unambiguous software requirement specification documents.
4. Introduce students to the methods for validating requirements, managing requirement changes, and ensuring traceability throughout the requirements engineering process, promoting the development of high-quality software systems.

Unit 1: Introduction to Requirements Engineering

Importance of requirements engineering in software development, Requirements engineering process: Elicitation, Analysis, Specification, and Validation, Types of requirements: Functional, Non-functional, System, and User requirements.

Unit 2: Requirement Elicitation Techniques

Interviews, surveys, questionnaires, and use case scenarios, Requirements workshops, brainstorming sessions, and role-playing, Prototyping, observation, and document analysis.

Unit 3: Requirement Analysis and Specification

Requirements modeling: Use case diagrams, activity diagrams, and state diagrams, Writing unambiguous and clear requirements, Software requirement specification document: Structure and importance.

Unit 4: Requirement Validation and Management

Techniques for validating requirements, Requirement change management, Traceability in requirements engineering.

Suggested Readings

1. "Software Requirements" by Karl E. Wiegers and Joy Beatty
2. "Mastering the Requirements Process: Getting Requirements Right" by Suzanne Robertson and James Robertson
3. "Requirements Engineering: Fundamentals, Principles, and Techniques" by Klaus Pohl

Practical Component

1. Conducting interviews and surveys for requirement gathering.
2. Developing use case and activity diagrams for a sample application.
3. Writing a software requirement specification document for a given case study.
4. Implementing requirement validation techniques on gathered requirements.
5. Using software tools for requirements management and traceability.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

FUNDAMENTALS OF CYBERSECURITY (DSE-1 / GE-3)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical		
Fundamentals of Cybersecurity	4	3L	0T	1P	-	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a clear understanding of cybersecurity principles (confidentiality, integrity, availability), recognize different types of cyber threats and attacks, and grasp the basics of symmetric and asymmetric encryption and hash functions.
2. Apply network security principles, configure and manage firewalls, IDS, and IPS, understand the role and configuration of VPNs, and design secure network architectures.
3. Integrate security into the software development lifecycle, identify and mitigate common web application vulnerabilities, and implement data protection techniques such as encryption, tokenization, and data masking.

Course Objectives

1. Provide students with a solid foundation in cybersecurity principles, types of cyber threats, and the basics of cryptography, along with an understanding of cybersecurity laws and ethics.
2. Equip students with knowledge of network security protocols, devices, and techniques, including firewalls, IDS/IPS, VPNs, and secure network design principles.
3. Enable students to understand and implement security measures throughout the software development lifecycle, identify and mitigate web application vulnerabilities, and apply data protection techniques.

Unit 1: Introduction to Cybersecurity

Principles of cybersecurity: confidentiality, integrity, availability (CIA), Types of cyber threats and attacks: malware, phishing, Denial of Service (DoS), Cybersecurity laws and ethics, Introduction to cryptography: symmetric and asymmetric encryption, hash functions.

Unit 2: Network Security

Basics of network protocols and devices, Firewalls, intrusion detection systems (IDS), and intrusion prevention systems (IPS), Virtual Private Networks (VPNs) and their importance, Secure network design principles.

Unit 3: Application and Data Security

Security in software development lifecycle (SDLC), Web application security vulnerabilities: SQL injection, XSS, CSRF, Data protection techniques: encryption, tokenization, data masking, Cloud security fundamentals and best practices.

Unit 4: Incident Response and Cybersecurity Frameworks

Basics of incident response: preparation, detection, containment, eradication, recovery, Introduction to cybersecurity frameworks: NIST, ISO/IEC 27001, Role of physical security in cybersecurity, Future trends in cybersecurity.

Suggested Readings

1. "Cybersecurity Essentials" by Charles Brooks, Christopher Grow, Philip Craig, and Donald Short
2. "The Art of Invisibility" by Kevin Mitnick
3. "Cybersecurity and Cyberwar: What Everyone Needs to Know" by P.W. Singer and Allan Friedman

Practical Component

1. Setting up and configuring a firewall and a basic IDS.
2. Conducting a simple penetration test on a web application to identify vulnerabilities.
3. Implementing basic encryption and hash functions for data security.
4. Developing an incident response plan for a given scenario.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

FOUNDATIONS OF AUGMENTED AND VIRTUAL REALITY (DSE-1 / GE-3)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical		
Foundations of Augmented and Virtual Reality	4	3L	0T	1P	-	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Understand the foundations of AR and VR
2. Apply principles of immersive design and cognitive aspects to create user interfaces and interactions, utilize storytelling and content creation techniques, and address ethical considerations in the development of AR and VR applications.
3. Evaluate case studies of AR and VR in various industries, understand the role of AR and VR in education and training, assess the social implications and business models, and navigate regulatory and legal considerations.

Course Objectives

1. Provide students with a comprehensive understanding of the history, evolution, and core technologies of Augmented Reality (AR) and Virtual Reality (VR), along with an exploration of current platforms and future trends.
2. Teach the principles of immersive design, cognitive aspects, user interface and interaction design, and the role of storytelling and content creation, while addressing ethical considerations in AR and VR.
3. Familiarize students with AR and VR development tools, basic 3D modeling, scripting and programming foundations, and the development, testing, and debugging of simple AR and VR applications.

Unit 1: Introduction to AR and VR

History and Evolution of AR and VR, Key Differences and Similarities, Core Technologies Behind AR and VR, Major AR and VR Platforms, Future Trends and Potential.

Unit 2: AR and VR User Experience

Principles of Immersive Design, Cognitive Aspects of AR and VR, User Interface and Interaction Design, Storytelling and Content Creation, Ethical Considerations in AR and VR.

Unit 3: AR and VR Development Basics

Introduction to AR and VR Development Tools, Basic 3D Modeling for AR and VR, Scripting and Programming Foundations, Simple AR and VR Application Development, Testing and Debugging AR/VR Applications.

Unit 4: AR and VR in Practice

Case Studies in Various Industries, AR and VR for Education and Training, Social Implications of AR and VR, Business Models in AR and VR, Regulatory and Legal Considerations.

Suggested Readings

1. "Augmented Reality: Principles and Practice" by Dieter Schmalstieg and Tobias Hollerer
2. "Understanding Virtual Reality: Interface, Application, and Design" by William R. Sherman and Alan B. Craig
3. "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile" by Tony Parisi

Practical Component

1. AR/VR Development Workshops and Lab Sessions
2. Prototype Development Projects
3. Case Study Analysis and Presentations

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Department of Computer Science and Engineering
Faculty of Technology
University of Delhi

Detailed Syllabus of Discipline Specific Elective (DSE) / Generic Elective (GE) courses offered for Minors / Specializations by the department in Semester 4

FUNDAMENTALS OF OPERATING SYSTEM (DSE-2 / GE-4)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Operating System	4	2L	0T	2P	-

Course Hours: L: 03 T: 00 P: 02

Unit 1: Introduction to Operating Systems

Overview of operating systems and their evolution, Functions and components of an operating system, Operating system structures: monolithic, layered, microkernel, Process management and scheduling

Unit 2: Memory and Storage Management

Basics of memory management: paging, segmentation, Virtual memory: concepts, demand paging, page replacement algorithms, File systems and storage management: structure, operations, access methods, I/O systems and management

Unit 3: Concurrency and Synchronization

Principles of concurrency: processes, threads, CPU scheduling, Synchronization mechanisms: semaphores, mutexes, condition variables, Deadlock: prevention, avoidance, detection, and recovery, Case studies: analyzing concurrency in real operating systems

Unit 4: Security and Protection

Operating system security fundamentals: threats, vulnerabilities, controls, User authentication and access control, Security policies and mechanisms in operating systems, Case studies of security and protection in modern operating systems

Suggested Readings

1. "Operating System Concepts" by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne
2. "Modern Operating Systems" by Andrew S. Tanenbaum and Herbert Bos
3. "Windows Internals" by Mark Russinovich, David A. Solomon, and Alex Ionescu for practical insights into Windows OS

Practical Component

1. Simulating process scheduling algorithms to understand their efficiency and fairness.
2. Implementing simple memory management techniques (e.g., paging or segmentation).
3. Developing a small program to demonstrate the use of synchronization mechanisms.
4. Conducting a security audit of an operating system configuration.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

FUNDAMENTALS OF DATA ANALYTICS (DSE-2 / GE-4)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Fundamentals of Data Analytics	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate an understanding of the data analytics lifecycle, including data collection, cleaning, analysis, and interpretation, and recognize the impact of data analytics through case studies.
2. Apply descriptive and inferential statistical techniques to analyze data, perform exploratory data analysis (EDA), and create meaningful data visualizations to effectively communicate insights.
3. Develop and implement basic predictive models using regression analysis (linear and logistic), apply classification techniques, conduct time series analysis, and validate and select appropriate models for given datasets.
4. Perform hands-on data analysis tasks, including exploratory data analysis, implementing regression models, creating visualizations, and conducting time series analysis, thereby gaining practical experience with real-world data.

Course Objectives

1. Provide a comprehensive introduction to data analytics, emphasizing its significance, various data types, and the data analytics lifecycle from data collection to interpretation.
2. Equip students with the knowledge of descriptive and inferential statistics, exploratory data analysis (EDA), and data visualization techniques essential for analyzing and interpreting data.
3. Introduce students to predictive analytics methods, including regression analysis, classification techniques, time series analysis, and model validation, enhancing their ability to predict and forecast based on data.
4. Familiarize students with popular data analytics tools such as R and Python, explore the applications of data analytics in business decision-making, discuss ethical considerations, and highlight emerging trends in the field.

Unit 1: Introduction to Data Analytics

Overview of data analytics and its significance in various domains, Types of data: structured, unstructured, semi-structured, Data analytics lifecycle: data collection, cleaning, analysis, interpretation, Case studies demonstrating the impact of data analytics.

Unit 2: Data Analysis Techniques

Descriptive statistics: measures of central tendency and variability, Inferential statistics: hypothesis testing, confidence intervals, Introduction to exploratory data analysis (EDA), Data visualization techniques and tools

Unit 3: Introduction to Predictive Analytics

Basics of regression analysis: linear and logistic regression, Overview of classification techniques, Time series analysis and forecasting basics, Introduction to model validation and selection

Unit 4: Data Analytics Tools and Applications

Introduction to data analytics software: R, Python and its libraries, Data analytics in business decision-making, Ethical considerations in data analytics, Emerging trends in data analytics

Suggested Readings

1. "Data Science for Business" by Foster Provost and Tom Fawcett
2. "Python for Data Analysis" by Wes McKinney
3. "Naked Statistics: Stripping the Dread from the Data" by Charles Wheelan

Practical Component

1. Performing exploratory data analysis using a dataset and presenting findings.
2. Implementing linear regression and logistic regression models on real-world data.
3. Creating data visualizations to interpret and communicate data insights.
4. Conducting a basic time series analysis project.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

OBJECT ORIENTED SOFTWARE ENGINEERING (DSE-2 / GE-4)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Object Oriented Software Engineering	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a solid understanding of object-oriented programming principles such as encapsulation, inheritance, and polymorphism, and utilize UML for object-oriented analysis and design.
2. Gather and analyze software requirements using use case diagrams, activity diagrams, class diagrams, sequence diagrams, and state diagrams, and apply analysis patterns to address common design problems.
3. Implement object-oriented design principles (SOLID, DRY, KISS) and advanced design patterns to develop robust software architectures, perform refactoring, and design systems for scalability, maintainability, and security.
4. Develop software applications using object-oriented programming languages, conduct unit and integration testing, and implement continuous integration/delivery pipelines, ensuring performance optimization and reliability of the systems.

Course Objectives

1. Provide a comprehensive understanding of object-oriented programming concepts, principles of software engineering, and agile methodologies as they apply to object-oriented software development.
2. Equip students with skills in object-oriented analysis, including requirements gathering, use of UML diagrams, and applying analysis patterns to model and solve common problems in software design.
3. Enable students to apply object-oriented design principles and patterns, understand architectural frameworks, and perform refactoring techniques to ensure scalable, maintainable, and secure software systems.
4. Train students in implementing object-oriented designs using programming languages, conducting unit and integration testing, and optimizing performance in object-oriented systems, along with understanding deployment and CI/CD practices.

Unit 1: Introduction to Object-Oriented Concepts

Principles of object-oriented programming: encapsulation, inheritance, polymorphism, Object-oriented analysis and design using UML, Design patterns: creational, structural, behavioral, Principles of software engineering and their application in object-oriented development, Methodologies, object oriented software estimation, Agile methodologies in object-oriented software development.

Unit 2: Object-Oriented Analysis

Gathering requirements: use case diagrams, activity diagrams, Analysis models: class diagrams, sequence diagrams, state diagrams, Identifying classes and objects, modeling relationships and behavior, Applying analysis patterns to common problems in software design, Object oriented analysis using methods of Rumbaugh

Unit 3: Object-Oriented Design

Design principles: SOLID, DRY, KISS, Advanced design patterns and their applications, Object-oriented architecture and frameworks, Refactoring techniques: improving and maintaining the design of existing code, Designing for scalability, maintainability, and security.

Unit 4: Object-Oriented Implementation and Testing

Implementing object-oriented designs in programming languages (e.g., Java, C#, Python), Unit testing and test-driven development in an object-oriented context, Path Testing, State based Testing, Class Testing, Integration testing and system testing strategies, Deployment strategies and continuous integration/delivery (CI/CD) pipelines, Performance optimization in object-oriented systems.

Suggested Readings

1. “Object-oriented software engineering” by Yogesh Singh and Ruchika Malhotra. PHI Learning Pvt. Ltd., 2012.
2. "Design Patterns: Elements of Reusable Object-Oriented Software" by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides
3. "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development" by Craig Larman
4. "Refactoring: Improving the Design of Existing Code" by Martin Fowler

Practical Component

1. Designing and implementing a software application using object-oriented principles.
2. Applying design patterns to a software design problem and implementing the solution.
3. Conducting unit and integration testing on an object-oriented software project.
4. Participating in a group project that follows an agile development process.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

CRYPTOGRAPHY ESSENTIALS (DSE-2 / GE-4)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
Cryptography Essentials	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Demonstrate a comprehensive understanding of the history and principles of cryptography, including symmetric (DES, AES) and asymmetric (RSA, ECC) key cryptography, and cryptographic hash functions (SHA, MD5).
2. Implement key exchange algorithms such as Diffie-Hellman, utilize digital signatures and certificates, understand the workings of Public Key Infrastructure (PKI), and apply cryptographic security protocols like SSL/TLS and PGP.
3. Understand and perform basic cryptanalysis techniques, identify and mitigate side-channel attacks, apply cryptographic techniques to secure data at rest, in transit, and in use, and navigate the legal and ethical landscape of cryptography.

Course Objectives

1. Introduce students to the history, principles, and essential concepts of cryptography, including both symmetric and asymmetric key cryptography and cryptographic hash functions.
2. Equip students with knowledge of key exchange algorithms, digital signatures, certificates, Public Key Infrastructure (PKI), and various cryptographic security protocols.
3. Familiarize students with the basics of cryptanalysis, side-channel attacks, and practical applications of cryptography in securing data, along with understanding the legal and ethical issues involved.

Unit 1: Foundations of Cryptography

History and principles of cryptography, Symmetric key cryptography: DES, AES, Asymmetric key cryptography: RSA, ECC, Cryptographic hash functions: SHA, MD5

Unit 2: Cryptographic Protocols and Practices

Key exchange algorithms: Diffie-Hellman, Digital signatures and certificates, Public Key Infrastructure (PKI) and its applications, Cryptographic security protocols: SSL/TLS, PGP

Unit 3: Cryptanalysis and Security

Basics of cryptanalysis: types and techniques, Side-channel attacks and countermeasures, Cryptography in practice: securing data at rest, in transit, and in use, Legal and ethical issues in cryptography

Unit 4: Advanced Cryptography and Emerging Trends

Introduction to quantum cryptography, Homomorphic encryption and its applications, Blockchain and cryptocurrency: cryptographic foundations, Future trends in cryptography

Suggested Readings

1. "Cryptography and Network Security: Principles and Practice" by William Stallings
2. "Understanding Cryptography: A Textbook for Students and Practitioners" by Christof Paar and Jan Pelzl
3. "Applied Cryptography: Protocols, Algorithms, and Source Code in C" by Bruce Schneier

Practical Component

1. Implementing basic encryption and decryption using symmetric and asymmetric algorithms.
2. Setting up a simple PKI environment and issuing digital certificates.
3. Conducting a simple cryptanalysis exercise on weak cryptographic algorithms.
4. Exploring the use of cryptographic libraries in software development.

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

3D GRAPHICS AND RENDERING (DSE-2 / GE-4)

CREDIT DISTRIBUTION AND PRE-REQUISITES OF THE COURSE

Course title	Credits	Credit distribution of the course			Prerequisite of the course (if any)
		Lecture	Tutorial	Practical	
3D Graphics and Rendering	4	3L	0T	1P	-

Course Hours: L: 03 T: 00 P: 02

Course Outcomes

At the end of this course, students will be able to:

1. Utilize complex 3D modeling techniques, texture mapping, and material design to create detailed and optimized 3D models, applying lighting and shading models effectively.
2. Develop and optimize real-time rendering algorithms, use shader programming and GPU resources efficiently, apply real-time shadow and light techniques, post-processing effects, and ensure performance optimization in rendering.
3. Perform keyframe animation, motion capture, rigging, skeletal animation, facial animation, and lip-syncing, and apply physics-based and procedural animation techniques to bring 3D models to life.

Course Objectives

1. Provide students with comprehensive knowledge and techniques in 3D modeling, texture mapping, material design, lighting, and shading models.
2. Equip students with the skills to implement and optimize real-time rendering algorithms, shader programming, and GPU utilization.
3. Familiarize students with keyframe animation, motion capture, rigging, skeletal animation, facial animation, lip-syncing, physics-based animation, and procedural animation techniques.

Unit 1: Advanced 3D Modeling

Complex 3D Modeling Techniques, Texture Mapping and Material Design, Lighting and Shading Models, Particle Systems and Effects, Optimization Techniques for 3D Models.

Unit 2: Real-Time Rendering

Rendering Algorithms, Shader Programming and GPU Utilization, Real-Time Shadow and Light Techniques, Post-Processing Effects, Performance Optimization in Rendering

Unit 3: Animation and Rigging

Keyframe Animation and Motion Capture, Rigging and Skeletal Animation, Facial Animation and Lip Syncing, Physics-Based Animation, Procedural Animation Techniques

Unit 4: Advanced Graphics Project

Conceptualizing a Complex 3D Scene, Integrating Advanced Graphics Techniques, Implementing User Interactions, Performance Analysis and Optimization, Project Presentation and Critique.

Suggested Readings

1. "Real-Time Rendering, Fourth Edition" by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman
2. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, and Kurt Akeley
3. "3D Math Primer for Graphics and Game Development" by Fletcher Dunn and Ian Parberry

Practical Component

1. 3D Modeling and Animation Workshops
2. Real-Time Rendering Projects
3. Graphics Programming Labs
4. Portfolio Development

List of Experiments

Note: The course instructor will design experiments/mini-projects to complete the practical component of the course.

Faculty of Technology
University of Delhi

The following proposals pertain to the B.Tech. programs currently running in Faculty of Technology at the University of Delhi.

1. The three departments of the Faculty of Technology, UoD, propose to offer the following Minors/ Specializations.

   i. Department of Computer Science and Engineering
      a. Artificial Intelligence and Machine Learning
      b. Data Science
      c. Software Engineering
      d. Blockchain and Cybersecurity
      e. Augmented Reality / Virtual Reality

   ii. Department of Electronics and Communication Engineering
      a. Telecommunication Networks
      b. VLSI Technology and System Design
      c. IoT System Design
      d. Computer Vision

   iii. Department of Electrical Engineering
      a. Robotics and Automation
      b. Sustainable Energy Engineering
      c. Electric and Hybrid Vehicle

2. When a student from a department pursues one of the Minors/Specializations in a domain offered by his/her parent department, he/she will be conferred a B.Tech. degree with a **Specialization** in the respective domain.

3. When a student from a department pursues one of the Minors/Specializations in a domain offered by a department other than his/her parent department, he/she will be conferred a B.Tech. degree with a **Minor** in the chosen domain.

4. All the departments are offering Minor Degree in their core disciplines to all students of other department(s).

5. A student of any department can take any Discipline Specific Core course as a Generic Elective (GE) course, provided the same/similar course has not been studied by the student in his/her parent department.

*** Observation**
When a student opts for a GE outside the faculty/department, time-table conflicts may arise.

Subjects for Department-wise Specializations and Minors for B.Tech. (Second Year) in Faculty of Technology

I. List of Generic Electives for Minors

1. Department of Computer Science and Engineering

S. No.	Sem	DSE/ GE	Minor in CSE (for ECE / EE)	Specializations (Open only for CSE) / Minors (Open to ECE / EE)				
				Artificial Intelligence & Machine Learning	**Data Science**	**Software Engineering**	**Blockchain and Cybersecurity**	**Augmented Reality / Virtual Reality**
1	III	DSE-1/ GE-3	Fundamentals of DBMS	Probability and Statistics for Computer Science	Probability and Statistics for Computer Science	Software Requirement Engineering	Fundamentals of Cybersecurity	Foundations of Augmented and Virtual Reality
2	IV	DSE-1/ GE-3	Fundamentals of Operating System	Fundamentals of Data Analytics	Fundamentals of Data Analytics	Object Oriented Software Engineering	Cryptography Essentials	3D Graphics and Rendering

2. Department of Electronics and Communication Engineering

S. No.	Sem	DSE/ GE	Minor in ECE (for CSE/ EE)	Specializations (Open only for ECE) / Minors (Open for CSE / EE)			
				Telecommunication Networks	**VLSI Technology and System Design**	**IoT System Design**	**Computer Vision**
1	III	DSE-1/ GE-3	Fundamentals of Analog Electronics	Introduction to Analog Communication	VLSI Technology and Design	Introduction to IoT	Fundamentals of Image Processing
2	IV	DSE-1/ GE-3	Introduction to Signals & Systems	Fundamentals of Digital Communication	Microelectronics Design	Introduction to IoT System Design	Image Filtering and Restoration

3. Department of Electrical Engineering

S. No.	Sem	DSE/ GE	Minor in EE (for CSE/ECE)	Specializations (Open only for EE) / Minors (Open for ECE / CSE)		
				Robotics & Automation	**Sustainable Energy Engineering**	**Electric and Hybrid Vehicle**
1	III	DSE-1/ GE-3	Fundamentals of Electrical Circuits	Fundamentals of Signal and Systems	Energy and Its Resources	Introduction to Electric and Hybrid Vehicles
2	IV	DSE-1/ GE-3	Electro-Mechanical Energy Conversion	Sensors & Transducers	Design and Evaluation of Photovoltaic Power Plants	Electric Vehicle Motor

II. List of Discipline-Specific Electives for Minors

1. Department of Computer Science and Engineering

S.No.	Semester	DSE	Paper Title
1.	III	DSE - 1	Object Oriented Programming
2.			Computational Statistics and Probability
3.			Front-end Web Design and Development
4.			Discrete Structures
5.	IV	DSE - 2	Foundations of Data Analysis
6.			Computer Graphics
7.			Introduction to IoT
8.			Optimization Techniques

2. Department of Electronics and Communication Engineering

S.No.	Semester	DSE	Paper Title
1.	III	DSE - 1	Computational Methods
2.			PCB based System Design
3.	IV	DSE - 2	Interfacing Electronics
4.			Modeling Electronic Circuits

3. Department of Electrical Engineering

S.No.	Semester	DSE	Paper Title
1.	III	DSE - 1	Non-Conventional Energy Resources
2.			Signal and Systems
3.	IV	DSE - 2	Electrical Machine Design
4.			Electrical Engineering Materials

This is subject to approval by the Competent Authority.

AEC- हिंदी भाषा और तकनीक

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
हिंदी भाषा और तकनीक	02	02	00	00		Nil

पाठ्यक्रम के उद्देश्य (Learning Objectives)

1. विद्यार्थी को हिंदी भाषा के अध्ययन से तकनीक की भूमिका से अवगत कराना।
2. कम्प्यूटर के प्रयोग से हिंदी क्षेत्र में बढ़ते रोजगार के अवसरों से विद्यार्थी को परिचित कराना।
3. विद्यार्थी को हिंदी के माध्यम से कम्प्यूटर की दुनिया से परिचित कराना।

शिक्षण प्रशिक्षण से अर्जित ज्ञान (Learning outcomes)

1. हिंदी के क्षेत्र में कम्प्यूटर के उपयोग से विद्यार्थी के लिए रोजगार के अनेक अवसर उपलब्ध हो सकेंगे।
2. विद्यार्थी व्यापक परिप्रेक्ष्य में कम्प्यूटर के उपयोग की संभावनाओं से परिचित हो सकेगा।

विस्तृत पाठ्यक्रम (Detailed Syllabus)

इकाई: 1 हिन्दी भाषा

हिन्दी भाषा की संरचना: वर्ण, शब्द, वाक्य (सामान्य परिचय)

हिन्दी का व्यावहारिक व्याकरण: संज्ञा, सर्वनाम, क्रिया, क्रिया - विशेषण, पदक्रम, अन्विति, विराम-चिह्न

देवनागरी लिपि व मानक वर्तनी

वैज्ञानिक व तकनीकी शब्दावली (50 शब्दों की सूची पाठ्यक्रम के साथ संलग्न)

इकाई: 2 हिन्दी भाषा और तकनीक

कंप्यूटर में हिन्दी प्रयोग से संबंधित प्रमुख तकनीकी सुविधाएं:

हिंदी टाईपिंग़ टूल्स - की बोर्ड – इन्स्क्रिप्ट, रेमिंग्टन और फोनेटिक

गूगल इनपुट टूल, माइक्रोसोफ़्ट इंडिक इनपुट टूल, गूगल वॉयस टाईपिंग़, ऑटोमैटिक स्पीच रिकग्निश्न

हिन्दी से संबधित प्रमुख फॉन्ट और यूनिकोड:

कोकिला, उत्साह, मंगल, निर्मला, अपराजिता, एरिअल यूनिकोड

हिंदी ई शब्दकोश:

हिंदी शब्द सिंधु 2.0 – हिंदी शब्दकोश, हिन्दवी डिक्शनरी

मशीनी अनुवाद से संबंधित प्रमुख सॉफ्टवेयर

कंठस्थ 2.0, भाषिनी, गूगल ट्रांसलेटर, माइक्रोसॉफ़्ट ट्रांसलेट, प्रोजेक्ट उडान

सहायक ग्रंथ (Reference Books)

1. कम्प्यूटर और हिंदी – हरिमोहन, तक्षशिला प्रकाशन, नई दिल्ली
2. हिंदी भाषा और कम्प्यूटर – संतोष गोयल, नटराज प्रकाशन, नई दिल्ली
3. आधुनिक हिंदी विविध आयाम – कृष्ण कुमार गोस्वामी, आलेख प्रकाशन
4. हिंदी भाषा – भोलानाथ तिवारी, किताब महल
5. कम्प्यूटर के भाषिक अनुप्रयोग – विजय कुमार मल्होत्रा, वाणी प्रकाशन, नई दिल्ली
6. अपना कम्प्यूटर अपनी भाषा में – राजेश रंजन, सामयिक प्रकाशन
7. https://www.microsoft.com/en-in/bhashaindia/downloads
8. https://kanthasth-rajbhasha.gov.in/
9. https://bhashini.gov.in/
10. https://udaanproject.org/
11. https://hindishabdsindhu.rajbhasha.gov.in/
12. https://www.hindwidictionary.com/

मूल्यांकन पद्धति (Assessment Method)

1. कुल अंक : 50
2. लिखित परीक्षा : 38
3. आंतरिक मूल्यांकन / प्रायोगिक कार्य / परियोजना कार्य / अनुवाद : 12

AEC- Sanskrit Language and Technology

Credit Distribution, Eligibility, and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Sanskrit Language and Technology	**02**	**02**	**00**	**00**	**Nil**	**Nil**

Learning Objectives

Information technology is taking place in education and language learning rapidly. Therefore, the objective of the course is to introduce the tools and technology to enhance the skill Sanskrit language through Technology.

Learning outcomes

Through this course, students will be aware of the basic Sanskrit and skilled in the language technology tools for Sanskrit. They will also know about various available tools for Sanskrit.

Syllabus of AEC

Unit 1- Introduction to Sanskrit Language **01 Credit**

Introduction to Sanskrit Alphabets, word and sentence
Sanskrit Writing Traditions: Devanagari, Roman (IAST)

Character Encoding for Sanskrit and other languages:

American Standard Code for Information Interchange (ASCII)
American National Standards Institute (ANSI)
Unicode: Unicode Transformation Format (UTF), UTF-8, UTF-16 and UTF-32/UCS-4.

Unit II- Sanskrit Language Unicode Typing and Other Computational Tools **01 Credit**

Typing Software: Baraha, Pramukh and other
Online Typing Tools: Google Input Tools
Voice Typing Tools: Google Voice Typing Tools
Mobile Typing Tools: Microsoft SwiftKey, Pramukh

Introduction to various available tools for Sanskrit.

Sanskrit Grammar Tools, and e-dictionary
Sanskrit Text Preservation and Search
Online Indexing Tools for Sanskrit Texts

Suggested Readings

1. Unicode Technical Report #17: Unicode Character Encoding Model". 2008-11-11. Retrieved 2009-08-08. At: http://www.unicode.org/reports/tr17/
2. Constable, Peter (2001-06-13). "Character set encoding basics". Implementing Writing Systems: An introduction. SIL International. Retrieved 2010-03-19.
3. Devanagari Unicode Chart at: http://unicode.org/charts/PDF/U0900.pdf
4. The Unicode Consortium: http://unicode.org/
5. http://baraha.com/v10/help/Keyboards/kan_phonetic.htm
6. https://www.google.co.in/inputtools/try/
7. Tools developed by Computational Linguistics Group, Department of Sanskrit, University of Delhi, Delhi-110007 available at: http://cl.sanskrit.du.ac.in
8. Tools developed by School of Sanskrit and Indic Studies, Jawaharlal Nehru University, New Delhi. available at: http://sanskrit.jnu.ac.in
9. Tools developed by Hyderabad University, New Delhi. available at: https://sanskrit.uohyd.ac.in/scl/

Assessment Method:

Internal Assessment:

Project/MCQ/Assignment	**12 Marks**
Theory Examination	**38 Marks**
Two Long Questions (one from each unit)	10 x 02 = 20
Three Short Notes (at least one from each unit)	06 x 03 = 18
Total	**50 Marks**