This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

SEMESTER-I

UNIVERSITY OF DELHI

CNC-II/093/1(22)/2022-23/223
Dated: 11.10.2022

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1-5 dated 18.08.2022]

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

Add the following:

Syllabi of Semester-I of the following departments under Faculty of Interdisciplinary & Applied Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

Department of Electronic Sciences

BSc. (Hons.) Electronics

Category-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Programming Fundamentals using Python ELDSC-1	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to the fundamental understanding of the Python programming language. The main objective is to help students learn to use the Python programming language to solve problems of interest to them. It introduces the core programming basics including data types, operators, input/output, control structures, iterative and recursive constructs, compound data types, and program design with functions. The course also discusses the fundamental principles of Object-Oriented Programming (OOP), as well as comprehensive data and information processing technique.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Read, write and debug python programs to solve computational problems.
CO2 Select and use a suitable programming construct and data objects like lists, sets, tuples and dictionaries for solving a given problem.
CO3 Be proficient in the handling of strings and functions
CO4 Use Python libraries
CO5 Articulate OOP concepts such as encapsulation, inheritance and polymorphism and use them in applications

SYLLABUS OF DSC-1

UNIT – I Starting with Python (12 Hours)

Introduction to Python: Python Interpreter-IDLE (script and interactive mode), Python shell, using Python as calculator, concept of data types; variables, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical operator, Boolean operator, Assignment operators, Membership operators(in and not in), Identity operators, Bit wise operator, Increment or Decrement operator), comments in the program, understanding error messages.
Creation of a Python Program: Input and Output Statements, Control statements -Branching (if-else, if-elif-else), indentation in python, iteration (using for, while), Conditional Statement, exit function, Difference between break, continue and pass, Nested conditionals

UNIT – II Strings and Lists (12 Hours)
Data objects in Python: Mutable and immutable
Strings- Creating and Storing Strings, Accessing Characters in String by Indexing (positive and negative), String Operations: concatenation, replication (*), membership, comparison, Slicing, string built-in functions, String method
Lists- Creating Lists, Accessing list elements, traversing a list , Aliasing a list, comparing list , list Operations:- concatenation, replication(*), membership, slicing, Indexing, nested list, list built-in functions List methods , del statement.
Sets: Creating sets, Sets built-in functions, Set Methods

UNIT – III Tuples and Dictionaries (12 Hours)
Tuples: Creating Tuples, Tuple operations: slicing, concatenation, replication, membership, comparing and deletion, tuple built-in functions
Dictionaries: Dictionary in python (key : value pairs), creating a dictionary, element accessing and traversing a dictionary, appending values, updating values, removing items from dictionary, membership, dictionary built-in functions, dictionary methods , clear statement
Object Oriented Programming: Introduction to Classes, Objects and Methods, Encapsulation, Inheritance, Polymorphism, Abstraction

UNIT – IV Functions and Modules (12 Hours)
Functions: Built in function (math, statistics), User defined functions: Defining Functions, arguments: positional, default, keyword, variable length arguments, scope of variables, parameter passing (string list, dictionary, tuples, sets), return statement, recursion, importing (using import) user defined function (path).
Modules in python: use of keyword from, namespacing, module aliasing, introduction to python packages (matplotlib, pandas, numpy, scikitlearn, nltk, openCV) and libraries and their applications

Practical component (if any) – Programming Fundamentals using Python Lab (30 Hours)

Learning outcomes

CO1 Develop algorithms and write programs in Python language for arithmetic and logical operations, conditional branching.
CO2 Write programs in Python language using construct and data objects like strings, lists, sets, tuples, dictionaries, Python libraries and use concept of OOP.
CO3 Prepare the technical report on the experiments carried.

1. Write a python menu driven program to calculate area of circle, rectangle, square using if-elif-else.
2. Write a python program to print Fibonacci series up to a certain limit (use 'while').
3. Write a python program to print the Pascal triangle.
4. Write a python program to find HCF (GCD) of two numbers.
5. Write a python program to find LCM of two numbers.
6. Write Python programs to illustrate the various functions of the "Math" module, "Statistics" module in Python.
7. Write a Python program to count number of vowels using sets in given string
8. Write a Python program to Remove all duplicates from a given string in Python
9. Write a Python program to count positive and negative numbers in a list
10. Write a Python program to find sum of elements in list
11. Write a python program to read a list of 'n' integers (positive and negative) and create two new lists one having all positive numbers and the other having all negative numbers from the given list. Print all three lists.
12. Write a python program to create a list of tuples from given list having number and its cube in each tuple
13. Create a Python program to create a dictionary which has record of a student information: Admission number, Roll Number, Name and Marks. Display information on the basis of Admission number
14. Write a python program which contains user defined functions as a 'module' to calculate area, perimeter or surface area , volume for various shapes like square, cube, circle, cylinder. The user defined functions should accept the values for calculation as parameters and calculated values should be returned. Import the module and use appropriate functions.
15. Create a menu driven Python program using user defined functions to implement a calculator to perform :

(a) Basic arithmetic operations
(b) log10(x), sin(x) , cos(x)

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

Essential/recommended readings

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. John V Guttag, —Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

5. Timothy A. Budd, —Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.

Suggestive readings

1. Kenneth A. Lambert, —Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
2. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
3. Paul Gries, Jennifer Campbell and Jason Montojo, —Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013.

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Circuit Theory &

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Circuit Theory & Network Analysis ELDSC-2	4	3	0	1	Course Admission Eligibility	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic circuit concepts in a systematic manner suitable for analysis and design.
- To study the steady state analysis of AC Circuits.
- To study and analyse electric circuits using network theorems.
- To study and design passive filters using R, L and C

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Study basic circuit concepts in a systematic manner suitable for analysis and design.
CO2 Determine AC steady state response.
CO3 Analyse the electric circuits using network theorems.
CO4 Determine frequency response of filters

SYLLABUS OF DSC- 2

UNIT – I Introduction to Circuits and DC Analysis (12 Hours)
Basic Circuit Concepts: Voltage and Current Sources, V- I characteristics of ideal voltage and ideal current sources, various types of controlled sources, passive circuit components, V-I characteristics, and ratings of different types of R, L, C elements.
DC Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Super node & Super mesh Analysis, Star-Delta Conversion.

UNIT – II AC Analysis (12 Hours)
Steady State Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Phasor, Complex Impedance, Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Node and Mesh Analysis for AC circuits. Star-Delta Conversion for complex impedances.
Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor.

UNIT – III Network Theorems (12 Hours)
Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. (Independent Sources)
AC circuit analysis using Network Theorems.

UNIT – IV Filters (9 Hours)
Filters and Resonance: Introduction to Passive Filters-High Pass, Low Pass, Band Pass & Band Stop Filters, Frequency response of RC Circuits-High pass and Low pass filters, Frequency response of Series and Parallel RLC Circuits. Resonance in Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth, Band Pass and Band Stop RLC Filters.

Practical component (if any) - Circuit Theory and Network Analysis Lab
(Hardware and Circuit Simulation Software) (30 Hours)
Learning outcomes

CO1 Verify the network theorems and operation of typical electrical circuits.
CO2 Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.
CO3 Prepare the technical report on the experiments carried.

1. Familiarization with Multimeter: Resistance, Capacitor and Inductor in series, parallel and series-parallel.
2. Familiarization with Oscilloscope: Measurement of Amplitude, Frequency and phase of a sinusoidal signal
3. Verification of Kirchhoff's Current Law.
4. Verification of Kirchhoff's Voltage Law
5. Verification of Norton's theorem.
6. Verification of Thevenin's Theorem.
7. Verification of Superposition Theorem.

8. Verification of the Maximum Power Transfer Theorem.
9. Design of Low Pass RC Filter and study of its Frequency Response.
10. Design of High Pass RC Filter and study of its Frequency Response.
11. Study of Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

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

Essential/recommended readings

1. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004)
2. M. Nahvi and J. Edminister, Electrical Circuits, Schaum's Outline Series, Tata McGraw Hill.(2005)
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)

Suggestive readings (if any)

1. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Semiconductor Devices

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Semiconductor Devices ELDSC-3	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the Physics of semiconductor devices
- To be able to plot and interpret the current voltage characteristics for basic semiconductor devices
- The student should be able to understand the behaviour, characteristics and applications of power devices such as SCR, UJT, DIAC, TRIAC, IGBT

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Describe the behavior of semiconductor materials
CO2 Reproduce the I-V characteristics of diode/BJT/MOSFET devices
CO3 Apply standard device models to explain/calculate critical internal parameters of semiconductor devices
CO4 Explain the behavior and characteristics of power devices such as SCR/UJT etc.

SYLLABUS OF DSC-3

UNIT – I Introduction to Semiconductors and Carrier Transport (12 Hours)
Basic Concepts of Semiconductors: Energy Bands in Solids, Concept of Effective Mass, Direct and Indirect Bandgap Semiconductors, Density of States (Qualitative understanding), Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors and its Temperature Dependence, Derivation of Fermi Level for Intrinsic and Extrinsic Semiconductors and its Dependence on Temperature and Doping Concentration

Carrier Transport Phenomena: Drift velocity, Mobility, Resistivity, Hall Effect , Conductivity, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes (Qualitative concepts), Continuity Equation.

UNIT – II P-N Junction Devices (12 Hours)
P-N Junction Diode: Space Charge at a Junction, Depletion Layer, Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Concept of Linearly Graded Junction
Diode Equation and I-V Characteristics (Qualitative), Zener and Avalanche breakdown Mechanism.
Metal Semiconductor Junctions, Ohmic and Rectifying Contacts, Zener diode, Tunnel diode, Varactor Diode, Optoelectronic Devices: LED, Photodiode, Solar cell, LDR, their Circuit Symbols, Characteristics and Applications

UNIT – III Bipolar Junction Transistors (12 Hours)
Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Energy Band Diagram of Transistor in Thermal Equilibrium, Emitter Efficiency, Base Transport Factor, Current Gain, Relation between alpha and beta, Base-Width Modulation, Early Effect, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations and their Applications.

UNIT – IV FET and Power Devices (9 Hours)
Field Effect Transistors: JFET, Channel Formation, Pinch-Off and Saturation Voltage, Input, Transfer and Output Characteristics.

MOSFET, NMOS, PMOS, Types of MOSFET, Circuit symbols, Working and Characteristic Curves of Depletion mode and Enhancement mode MOSFET (both N channel and P Channel), Complimentary MOS (CMOS) as an Inverter.

Power Devices: Introduction to UJT, SCR, TRIAC, DIAC, IGBT and their Basic Constructional Features (Schematic Diagram), Characteristics and Applications.

Practical component (if any) - Semiconductor Devices Lab (30 Hours)
(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Examine the characteristics of Semiconductor Devices
CO2 Perform experiments for studying the behaviour of semiconductor devices for circuit design applications
CO3 Calculate various device parameters values from their I-V Characteristics
CO4 Interpret the experimental data for better understanding of the device behaviour

1. Study of the I-V Characteristics of Diode – Ordinary and Zener, Solar Cell, Photodiode
2. Study of the I-V Characteristics of the CE, CB and CC configurations of BJT and obtain Input and Output impedances and Gains (Any one configuration to be assigned at the time of Examination)
3. Study of the I-V Characteristics of JFET/MOSFET
4. Study of the I-V Characteristics of the UJT
5. Study of the I-V Characteristics of the SCR
6. Study of the I-V Characteristics of DIAC and TRIAC
7. Study of Hall Effect.

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

Essential/recommended readings

1. S.M Sze Semiconductor Devices: Physics and Technology,2nd Edition, Wiley India Edition
2. Ben G Streetman and S. Banerjee Solid State Electronic Devices, Pearson Education
3. Dennis Le Croissette, Transistors, Pearson Education
4. Jacob Millman and Christos Halkias: Electronic Devices and Circuits, Tata McGraw-Hill Edition

Suggestive readings

1. Nutan Kala Joshi and Swati Nagpal, Basic Electronics with Simulations and Experiments, Khanna Publishers (2021)
2. Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons
3. Kannan Kano, Semiconductor Devices, Pearson Education

Common Pool of Generic Electives (GE) Courses
Offered by Department of Electronic Sciences

Category-IV

GENERIC ELECTIVES (GE-1): Fundamentals of Electronics

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Electronics ELGE-1A	**4**	**3**	**0**	**1**	**None**	**None**

Learning Objectives

The Learning Objectives of this course are as follows:

- The paper equips the learners about basic circuit knowledge to analyze electric circuits using network theorems.
- Understand diode and it's applications in clipping and clamping circuits, Rectifiers and design regulated power supply using Zener diodes.
- To be able to plot the current voltage characteristics of Diode, Transistors and its different biasing conditions
- Usage of semiconductor devices in designing the circuits.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Study basic circuit concepts in a systematic manner suitable for analysis and design and further analyze the electric circuit using network theorems.
CO2 To understand the different types of semiconductor devices and their characteristics
CO3 Illustrate about working of transistors, transistor-based amplifiers and its biasing.
CO4 Explain the concepts of feedback and oscillations and construct feedback amplifiers

SYLLABUS OF GE-1

UNIT – I Basic Resistive Circuit (12 Hours)

Ohm's Law, resistors in series and parallel combinations. DC voltage sources: ideal and non-ideal cases; DC current sources: ideal and non-ideal cases; Introduction to Kirchhoff's current law, Kirchhoff's voltage law, voltage divider circuit, current divider circuit; source

transformations– voltage source to current source and current source to voltage source, basic problems. Resistive circuits: Thevenin's theorem, Norton theorem, Superposition theorem, Maximum power transfer theorem.

UNIT – II PN-junction diode and its applications (12 Hours)

PN junction, Unbiased PN junction, Forward and Reversed biased condition, IV-characteristics of PN junction diode, types of diodes – Zener diode, photo diode, LED.

Diode circuits and power supplies. Half and full wave rectifiers, Bridge rectifier (qualitative comparison), Regulated power supply using Zener diode, Basic Clipper and Clamper circuits using diodes.

UNIT – III Bipolar Junction Transistors (BJT) and Biasing (12 Hours)

NPN Transistor and basic transistor action, Definition of α, β and γ and their interrelations, leakage currents, Modes of operation, Input and output characteristics of CB, CE and CC Configurations. Transistor biasing, thermal runaway, stability and stability factor, Fixed bias without and with R_E, collector to base bias, voltage divider bias and emitter bias ($+V_{CC}$ and $-V_{EE}$ bias), circuit diagrams and their working.

UNIT – IV BJT Applications (12 Hours)

BJT amplifier (CE), dc and ac load line analysis, Operating point, Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances. Positive feedback and Barkhausen criteria for oscillations.

Practical component (if any) - Fundamentals of Electronic Lab (30 Hours)
(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Verify the network theorems and operation of typical electrical circuits.
CO2 Study various stages of a zener diode based regulated power supply.
CO3 Understand various biasing concepts, BJT based amplifiers.

1. Study and operation of digital multi-meter, function generator, regulated power supply, CRO, etc.
2. Verification of KVL and KCL.
3. Verification of Superposition theorem.
4. Verification of Thevenin's, Norton's Theorem
5. Verification of Maximum power transfer theorem.
6. To plot the IV-characteristics of a ordinary and Zener diode and LED
7. Study of Half wave and Full Wave Rectifiers
8. Study of Fixed Bias, Voltage divider bias Feedback configuration for transistors.
9. Study of transistor amplifier circuit.

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

Essential/recommended readings

1. R. L. Boylestad & Louis Nashlesky (2007), Electronic Devices &Circuit Theory, Pearson Education.
2. David A. Bell (2008), Electronic Devices and Circuits, Oxford University Press.
3. B L Theraja and AK Theraja, A Textbook Of Electrical Technology - Vol I.

Suggestive readings

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)

GENERIC ELECTIVES (GE-2): Data Engineering and Analytics

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Data Engineering and Analytics ELGE-1B	4	3	0	1	None	Basic Knowledge of Python Programming Language

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of this course is to introduce students to data analysis and impart them skills to solve data analytics problem. Data Engineering is basically designing and building pipelines that transform and transport data into a highly usable format before it reaches the Data Scientists or other end users. These pipelines must take data from many disparate sources and collect them into a single warehouse that represents the data uniformly as a single source of truth.

Learning outcomes

The Learning Outcomes of this course are as follows:
CO1 Use data analysis tools in the pandas library.
CO2 Develop understanding of basic data analysis techniques.
CO3 Collect, explore, clean, munge and manipulate data.
CO4 Solve real world data analysis problems.
CO5 Build data science applications using Python based toolkits.

SYLLABUS OF GE-2

UNIT – I Mathematical Foundation for Data Engineering (12 Hours)

Linear Algebra: Vectors, Matrices; Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation; Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem ; Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P-hacking, Bayesian Inference

UNIT – II Introduction to Data Engineering and Data Science (12 Hours)

Relationship between Data Engineering and Data Science, Types of Data, Data file formats. Overview of Data Repositories; Data Warehouses, Data Marts, and Data Lakes. Introduction to ETL, ELT, and Data Pipelines. Data Integration Platforms, Traits of Big data, Analysis vs Reporting, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis. Introduction to Cloud Computing in Data Science

Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, stats models

UNIT – III Understanding Pandas and Data Wrangling (12 Hours)

Getting Started with Pandas: Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Cleaning, Preparation and Transformation.

Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting.

UNIT – IV Data Aggregation and Analysis (9 Hours)

Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation

Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.

Practical component (if any) - Data Engineering and Analytics Lab (Python) (30 Hours)

Learning outcomes

CO1 Implement various data analysis tools in the pandas library.

CO2 Implement various basic data analysis techniques, clean and filter and manipulate data.

CO3 Solve real world data analysis problems.

1. Create a Data Frame and perform Matrix-like Operations on a Data Frame
2. Implement basic array statistical methods (sum, mean, std, var, min, max, argmin, argmax, cumsum and cumprod) and perform sorting operation with sort method.
3. Create a data frame with a following structure using pandas

EMP ID	EMP NAME	SALARY	START DATE
1	Satish	50000	01-11-2017
2	Reeya	75000	12-05-2016

3	Jay	100000	22-09-2015
4	Roy	45000	08-01-2017
5	Serah	55000	06-02-2018

4. Load Pima Indians Diabetes dataset (Source: https://archive.ics.uci.edu/ml/datasets/diabetes). Implement the following
   i. Data Cleaning and Filtering methods (Use NA handling methods, fillna function arguments).
   ii. Implement descriptive and summary statistics.
   iii. Plot histogram, bar plot, distplot for features/attributes of the dataset
5. Load Boston Housing Price dataset and perform
   i. Data cleaning and filtering method on the dataset.
   ii. Implement descriptive and summary statistics
   iii. Plot 'distplot' for target variable and 'heatmap' for the correlation in dataset.
6. For above data set, perform grouping the data using index in pivot table, aggregate on specific features with values.
7. For Superstore sales data, perform Time Series Data Analysis.
8. Creating cloud account Amazon/Azure/Google/IBM to store images /files / programs..

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

Essential/recommended readings

1. The Data Engineering Cookbook - Mastering The Plumbing Of Data Science by Andreas Kretz.
2. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python by Peter Bruce, Andrew Bruce, Peter Gedeck, Shroff/O'Reilly. ISBN: 8194435006-978
3. Data Engineering A Complete Guide - 2020 Edition by Gerardus Blokdyk, 5starcooks. ISBN: 1867316718-978
4. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling by Ralph Kimball, Margy Ross, Wiley. ISBN: 978-1118530801

Suggestive readings -

1. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 978-9352134915
2. Data Science from Scratch: First Principles with Python by Joel Grus, Shroff/O'Reilly. ISBN: 9352138326-978

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

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- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

SEMESTER-II

UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/
Dated: 14.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 38-1/ (38-1-5) dated 08.12.2022]

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

Add the following:

Syllabi of Semester-II of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

Category I

BSc. (Hons.) Electronics

DISCIPLINE SPECIFIC CORE COURSE-4 (DSC-4) – : Basic Instrumentation and Measurement Techniques

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Instrumentation and Measurement Techniques	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of this subject is to provide insight into electronic instruments being used in the industries and labs. It details the basic working and use of different instruments used for measuring various physical quantities. Also, it details the identification, classification, construction, working principle and applications of various transducers used for displacement, temperature, pressure and intensity measurement.

Learning outcomes

After completion of the course, students will be able to-

Describe the working principle of different measuring instruments.

Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.

Understand the significance of different measuring instruments including oscilloscopes.

UNIT – I Fundamentals of Electronic Measurements (12 Hours)

Qualities of Measurement: SI system of units. Specifications of instruments, their static and dynamic characteristics. Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis.

Basic Measurement Instruments: PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, ohm meter, AC measurement (rectifier type, electro dynamo meter), Watt meter. Digital voltmeter systems (integrating and non-integrating types), digital multimeter,

Connectors and Probes: low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.

UNIT – II Impedance Measurement and Power Supplies (12 Hours)

Measurement of Resistance and Impedance: Low Resistance: Kelvin's bridge method, Medium Resistance by Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Anderson's bridge, Measurement of Capacitance, De Sauty's bridge, Measurement of frequency, Wien's bridge.

Regulated Power Supplies: Power Supply characteristics, Fixed power supply (78XX based), Dual power supplies (78XX and 79XX based), Variable power supply (LM317 based), current limiting, short-circuit shut down. Introduction of switch mode power supply (SMPS)

UNIT – III Oscilloscopes and Signal Generators (12 Hours)

Electronic Displays: The Cathode Ray Oscilloscope (CRO): Block diagram of a General Purpose Oscilloscope and its basic operation. Measurement of voltage, frequency and phase by oscilloscope. Oscilloscope probes. Sampling Oscilloscope. Digital storage oscilloscope (DSO), advantages and applications, Oscilloscope specifications (bandwidth, sensitivity, rise time).

Signal Generators: Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generators.

UNIT – IV Transducers and Sensors (09 Hours)

Transducers and sensors: Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area, air gap and permittivity Type), Inductive (LVDT) and piezoelectric transducers. Measurement of displacement, Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

Practical component (if any) – Basic Instrumentation and Measurement Techniques Lab – 30 Hours

1. Design of ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge.
3. Measurement of Capacitance by De Sauty's bridge.
4. Measurement of Inductance by Anderson's bridge.
5. To determine the characteristics of resistance transducer - Strain Gauge.
6. To determine the characteristics of an LVDT.
7. To study the variations of thermo-emf of a thermocouple. (Type J/Type K)
8. To study the I-V characteristics of Solar Cell.
9. To study the Characteristics of LDR, Photodiode
   (i) Variable Illumination (ii) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor.

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

Essential/recommended readings

1. H. S. Kalsi, Electronic Instrumentation, 3rd Edition, Tata Mcgraw Hill, (2006).
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
3. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, 3rd Edition, Pearson Education (2005).
4. David A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford University Press (2013).
5. R. A. Witte, Electronic Test Instruments, Analog and Digital Measurements, 2nd Edition, Pearson Education (2004).
6. A. K. Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpatrai and Sons (2007).
   K. Lal Kishore, Electronic Measurements and Instrumentation, 1st edition, Pearson Education India (2009).

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Digital Electronics

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Digital Electronics	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To represent information in various number systems.
- To convert data from one number system to another and do various arithmetic operations.
- To analyze logic systems and to implement optimized combinational circuits using Karnaugh Map.
- To analyze and implement sequential circuits using state machines.
- To analyze various memories and programmable logic devices.
- To analyze and understand the working of data converters.

Learning outcomes

After completion of the course, students will be able to-
Understand the concept of the number system with emphasis on binary numbers, its algebra and minimization techniques.
Understand basic logic gates, concepts of Boolean algebra and techniques to reduce/simplify Boolean expressions.
Analyze and design combinational as well as sequential circuits.
Understand the concepts related to Memories and PLD's.
Understand the working of analog to digital converters, digital to analog converters.

SYLLABUS OF DSC- 5

UNIT – I Introduction to Digital Electronics (09 Hours)
Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, Octal and Hexadecimal arithmetic, Addition, subtraction by Complements (1's and 2's) method, Binary Multiplication by computer method, Signed

numbers, Binary Codes (BCD, 84-2-1, excess-3, Gray) BCD addition, Error detecting/correcting code (Parity, Hamming).
Logic Gates and Boolean Algebra: Truth table and symbolic representation of logic gates and their implementation using Universal gates, Basic postulates and fundamental theorems of Boolean algebra.

UNIT – II Combinational Circuit Design (12 Hours)
Canonical and Standard forms, Standard representation of logic functions (SOP and POS), Simplification of Boolean functions (up to 5 variables) using (i) Kmap (ii) Tabulation method, Binary Adder, Binary subtractor, parallel adder/subtractor, BCD adder, Code convertors.
Encoder, Decoder, Multiplexer, Demultiplexer, Implementing logic functions with Decoder and multiplexer.

UNIT – III Sequential Circuits (12 Hours)
Sequential logic design: Latches and Flip flops, S-R, D, J-K, master slave, T Flip flops and their characteristic equation, Clocked and edge triggered Flip flops, conversion between flip flops, Shift Registers, Universal Shift register, Bidirectional Shift Register, Ring counter and Johnson counter, Counters (synchronous, asynchronous and modulo-N) and their timing sequence.
Synchronous Sequential circuit synthesis: State Tables, State Transition Diagrams, minimization, state assignments, realization with T, D and JK flip flops, Finite state machine- Mealy and Moore model

UNIT – IV Signal Conversion, Memories and Logic Families (12 Hours)
A-D and D-A Conversion: 4 bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all).
Memories: ROM, PROM, EPROM, EEPROM, Bipolar RAM, static and dynamic RAM, Memory Expansion (Word size and Word Capacity).
Programmable Logic Devices: Combinational circuit Implementation using PROM, PLA and PAL.
Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison

Practical component (if any) - Digital Electronics Lab *(Hardware and Circuit Simulation Software)* – 30 Hours

1. To verify and design AND, OR, NOT, XOR and XNOR gates using NAND gates.
2. To convert a Boolean expression into a logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.

6. Implement a Boolean function using 4 X 1 multiplexer.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type, JK, JK Master slave).
8. Design a SISO, SIPO shift register.
9. Design an asynchronous/ synchronous Up/Down counter using D/T/JK Flip-Flop.
10. Design a non sequential counter using D/T/JK Flip flop.
11. Design a R-2R DAC.
12. Design an ADC circuit using ADC0804.

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

Essential/recommended readings

1. M. Morris Mano, "Digital System Design," Pearson Education Asia.
2. Thomas L., "Flyod, Digital Fundamentals," Pearson Education Asia.
3. W. H. Gothmann, "Digital Electronics: An Introduction To Theory And Practice," Prentice Hall of India.
4. Millman & Grabel, "Microelectronics," Tata McGraw Hill.
5. Donald D. Givone, " Digital Principles and Design," Tata McGraw- Hill.
6. R. P. Jain, "Modern digital Electronics," Tata McGraw- Hill.

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

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Analog Electronics-I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analog Electronics-I	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand diodes (pn diode and Zener diode) and its applications in clipping and clamping circuits, rectifiers and voltage regulation (using Zener diodes) and concept of Power Supply.
- Understand frequency response of BJT and MOSFET amplifiers.
- Understand the concept of feedback and design feedback amplifiers and oscillators.
- Understand different power amplifiers and single tuned amplifiers.

Learning outcomes

After completion of the course, students will be able to-
Illustrate about rectifiers, transistor and MOSFET amplifiers and its biasing. Also compare the performances of its low frequency models.
Describe the frequency response of MOSFET and BJT amplifiers.
Explain the concepts of feedback and construct feedback amplifiers and oscillators.
Summarizes the performance parameters of amplifiers with and without feedback

SYLLABUS OF DSC-6

UNIT – I Diode applications (09 Hours)

Diode Circuits: Ideal diode, piecewise linear equivalent circuit, dc load line, static and dynamic resistance, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, Voltage doubler
Filters: Circuit diagram and explanation of shunt capacitor filter with waveforms.
Voltage Regulator: Zener diode regulator circuit diagram and explanation for load and line regulation

UNIT – II BJT based Amplifiers and Oscillator (12 Hours)

Transistor: Input and Output Characteristics, Concept of Biasing and its significance, Concept of DC and AC analysis. Overview of Common Emitter BJT amplifier, Concept of Darlington pair
Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers (Class A, Class B, Class AB, Class C, Class D), Concept of Class A single ended power amplifier, Transformer coupled Class A power amplifier and complementary symmetry Class B push pull power amplifier, overall efficiency, concept of crossover distortion, harmonic distortion and heat sinks.

Feedback Amplifiers: Concept of feedback, negative and positive feedback, voltage (series and shunt), feedback amplifiers gain, input and output impedances. Barkhausen criterion for oscillations, RC phase shift oscillator

UNIT – III MOSFET Fundamentals (12 Hours)

MOSFET: Operation of n-channel and p-channel MOSFETs, Overview of Depletion and Enhancement MOSFET, Transfer Characteristics, Drain Characteristics, MOSFET as a switch. short channel effects, non-ideal effects in MOS transistors: the finite output resistance in the saturation region, the body effect, subthreshold conduction, breakdown effects, and temperature effects.

MOSFET DC analysis: Biasing circuits- drain feedback, voltage divider, source feedback, bias stability, Graphical analysis, load line.

UNIT – IV MOSFET based Amplifiers (12 Hours)

MOSFET AC analysis: AC equivalent circuit of MOSFET, MOSFET parameters,

MOSFET Amplifiers: circuit and small signal model of Common Source amplifier, small signal parameters: input resistance, output resistance and voltage gain, circuits of Common Drain and Common Gate configurations. Comparison of BJT based (CE, CB and CC) and MOSFET based (CS, CD, CG) - Qualitative only.

Multistage MOSFET circuits: Cascaded circuits and Cascode circuits, effect of multistage circuits on gain and bandwidth.

MOSFET Application circuits: CMOS as inverter circuit, depletion mode n-MOSFET and p-MOSFET as load device

Practical component (if any) - Analog Electronics-I Lab – 30 Hours

(Hardware and Circuit Simulation Software)

1. Study of the half wave or full wave rectifier
2. Study of Zener diode as voltage regulator.
3. Study of any two types of
   (a) clipping circuits
   (b) clamping circuits.
4. Study of a Single Stage CE amplifier.
5. Study of Class A or Class B Power Amplifiers.
6. Study of Voltage divider bias for MOSFET
7. Study of the frequency response of Common Source MOSFET amplifier.
8. Study of MOSFET based Phase Shift Oscillator

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

Essential/recommended readings

1. Electronic Devices and circuit theory, Robert Boylestad and Louis Nashelsky, 9th Edition, 2013, PHI
2. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)
3. Electronic devices, David A Bell, Reston Publishing Company
4. Giovanni Saggio, Principles of Analog Electronics, CRC Press (2014)
5. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
6. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
7. J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw

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

Category-IV
Pool of Generic Electives offered by Department of Electronic Science

GENERIC ELECTIVES (GE-2A): **Digital System Design**

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Digital System Design	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil	Electronic Science

Learning Objectives

In addition to familiarization with the combinational and sequential circuits, students will be adept in using simulation of digital circuits on software, which is in high demand, for designing combinational or sequential circuits. As there are lot of industrial and research-based job opening in the area, the course offers a hands-on in designing digital systems on hardware and testing with a holistic approach to the subject, making students ready for the industry or research

Learning outcomes

After completion of the course, students will be able to-

Understand and represent numbers in powers of base and concepts of Boolean algebra.
Understand basic logic gates and minimization techniques.
Analyze and design combinatorial circuits.
Analyze and design sequential circuits.

SYLLABUS

UNIT – I Number Systems and Boolean Algebra (09 Hours)

Number System and Boolean algebra: Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1's and 2's), Signed and unsigned numbers, addition and subtraction, Gray Code. Boolean algebra- Positive and negative logic. Boolean laws, De Morgan's theorems, simplification of Boolean expressions-SOP and POS

UNIT – II Logic Gates and Minimization (12 Hours)

Logic gates and Karnaugh map: Logic gates- basic logic gates-AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map minimization of 3 and 4 variable functions/expressions.

UNIT – III Combinational Circuits (12 Hours)

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full), Subtractor (half and full), Parallel adder/subtractor, Encoder and Decoder, Understanding VHDL program of a Full Adder and 3 to 8 decoder

UNIT – IV Flip Flops and Counters (12 Hours)

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (synchronous and asynchronous, ring and Johnson)

Practical component (if any) - Digital System Design Lab – 30 Hours

(Hardware and Circuit Simulation Software)

To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. Design a Half and Full Adder.
3. Design a Half and Full Subtractor.
4. Implement Boolean functions using 8X1 and 16X1 Multiplexers.
5. Implement Boolean functions using decoder.
6. Implement an encoder.
7. Study of counters using dedicated counter ICs.
8. Study of registers (SISO, SIPO, PISO and PIPO) using universal shift register IC.

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

Essential/recommended readings

1. M. Morris Mano Digital System Design,Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum_s Outline Series, Tata McGraw- Hill (1994)

GENERIC ELECTIVES (GE-2B): Data Visualization Techniques

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Data Visualization Techniques	4	3	0	1	Class XII Passed with Maths	Basic Knowledge of Python Programming Language	Electronic Science

Learning Objectives

This course is all about data visualization, the art and science of turning data into readable graphics. It enables the students to design and create data visualizations based on data available and tasks to be achieved. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding. Students will create their own data visualizations, and learn to use Open-Source data visualization tools.

Learning outcomes

After completion of the course, students will be able to-

Design and create data visualizations.
Conduct exploratory data analysis using visualization.
Craft visual presentations of data for effective communication.
Use knowledge of perception and cognition to evaluate visualization design alternatives.
Design and evaluate color palettes for visualization based on principles of perception.
Apply data transformations such as aggregation and filtering for visualization.
Identify opportunities for application of data visualization in various domains.

Tools Required: Open-source Visualization tools, Python, Plotly, Tableau

SYLLABUS

UNIT – I Understanding Data Visualization (09 Hours)

Introduction to Data Visualization, Various tools for Data Visualization. Introduction to Numpy, Pandas and Matplotlib. Structured & Semi-structured Dataset, Data Cleaning and Preparation. Handling Missing Data, Data Transformation. Basic Plotting with Matplotlib, Dataset on Immigration e.g. Canada (source: https://open.canada.ca)/ any other. Univariate and Multivariate Visualization. Introduction to cloud computing.

UNIT – II Data Visualization Techniques (12 Hours)

Data Visualizations Techniques: Line Plots, Area Plots, Histograms, Bar Charts, Pie Charts, Box Plots, Scatter Plots, Bubble Plots, Waffle Charts, Word Clouds, Seaborn and Regression Plots, Creating Maps and Visualizing Geospatial Data - Introduction to Folium, Maps with Markers, Choropleth Maps.

UNIT – III Creating Dashboards with Plotly (12 Hours)

Introduction to Seaborn, Basic plotting with Seaborn. Introduction to Plotly. Scatter chart, Bubble Plot, Pie chart, Gantt chart, Contour plotting, Sunburst and Polar charts, Heatmaps.

UNIT – IV Data Visualization using Tableau (12 Hours)

Introduction to Tableau Desktop, connecting to dataset, Data preparation, Filtering and sorting data, Creating basic chart types (bar charts, line charts etc.), Assembling a dashboard layout, Using dashboard filters, Transform the data, Simple calculations in Tableau, Creating advanced chart types. Introduction to Data Story.

Practical component (if any) - Data Visualization Techniques Lab – 30 Hours

(Perform practical on Dataset available at Kaggle / Github / UCI Machine Learning Repository)

1. Visualization of Spreadsheet Models.
2. Visualization of Semi-Structured Data.
3. Interactive Plots in Python and Tableau.
4. Hierarchical and Topographical Data Visualizations in Tableau.
5. Calendar Heatmaps and Flow Data Visualizations in Python.
6. Time Series Data Visualization in Plotly.
7. Creating cloud account Amazon/Azure/Google/IBM to store images /files / programs.
8. Use a dataset that contains immigration details e.g. Canada for a given duration of 30 years (Canada Immigration Dataset, source: https://open.canada.ca) or any other
    a. Create an area plot for top 6 immigrant countries in a given duration.
    b. Create and year-wise immigrant bar chart from India to Canada in a given duration.
    c. Create a boxplot of immigrants for three given countries.

d. Show the total no. of immigrants using Area Chart and Pie chart for two given countries.
e. Create a scatter Histogram for the immigrants in the given year for two specific countries.

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

Essential/recommended readings

1. Data Visualization with Python for Beginners: Visualize Your Data using Pandas, Matplotlib and Seaborn by AI Publishing. ISBN: 1733042680-978
2. Learn and Practice Data Visualization using Python by Swapnil Saurav, Eka Publishers. ISBN: 8194633426-978
3. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: -978 9352134915
4. Data Visualization with Tableau by Praveen Kumar, Gurucool Publishing. ISBN: 8194746997-978
5. Interactive Dashboards and Data Apps with Plotly and Dash by Elias Dabbas, Packt Publishing Limited. ISBN: 1800568914-978

Suggestive readings -

1. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 9352134915-978
2. Data Science from Scratch: First Principles with Python by Joel Grus, Shroff/O'Reilly. ISBN: 9352138326-978

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

SEMESTER-III

UNIVERSITY OF DELHI

CNC-II/093/1(25)/2023-24/79
Dated: 15.06.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 60/ (60-1-4) dated 03.02.2023]

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

Add the following:

Syllabi of Semester-III of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

Department of Electronic Science

BSc. (Hons.) Electronics

DISCIPLINE SPECIFIC CORE COURSE – 7: Engineering Mathematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Engineering Mathematics ELDSC-7	4	3	00	1	Course Admission Eligibility	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (12 Hours)

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

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

Special functions: Beta and gamma functions, error functions

UNIT – II (11 Hours)

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

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

UNIT – III (11 Hours)

Sequences and Series: Sequences and its kind, Limits of a sequence, Convergent, Divergent and oscillatory sequences.
Convergence of Infinite series, Tests of Convergence: Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series Test.

UNIT – IV (11 Hours)

Complex Variables Analysis: Complex Variables, Complex functions, Continuity, Differentiability, Analyticity, Cauchy-Riemann (C-R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Functions, Trigonometric Functions, Hyperbolic Functions.
Complex Integration: Line integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula. Taylor series-exponential, logarithmic and trigonometric functions.

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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

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

Essential/recommended readings

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

Suggestive readings

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

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

DISCIPLINE SPECIFIC CORE COURSE – 8: Analog Electronics-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analog Electronics-II ELDSC-8	4	3	0	1	Course Admission Eligibility	Basic knowledge of BJT based circuits

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (12 Hours)

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

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

Op-Amp Parameters (IC741): Differential Input Resistance, Output Resistance, Input Capacitance, Input Voltage Range, Large Signal Voltage Gain, Offset Voltage Adjustment Range, Input Offset Voltage, Input Offset Current, Input Bias Current, 97

Common Mode Rejection Ratio, Supply Voltage Rejection Ratio, Bandwidth, Gain Bandwidth Product, Slew Rate.

UNIT – II (11 Hours)

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

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

UNIT – III (11 Hours)

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

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

UNIT – IV (11 Hours)

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

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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

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

Essential/recommended readings

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

Suggestive readings

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

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

DISCIPLINE SPECIFIC CORE COURSE – 9: Signals and Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Signals and Systems ELDSC-9	4	3	0	1	Course Admission Eligibility	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (11 Hours)

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

UNIT – II (11 Hours)

Linear Time -Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative. LTI systems with and without 100

memory, invariability, causality, stability, unit step response. Differential and Difference equation formulation. Block diagram representation of first order systems.

UNIT – III (12 Hours)

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

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

UNIT – IV (11 Hours)

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

Practical component (if any) – Signals and Systems

(Scilab/MATLAB/ OCTAVE/Other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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

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

Essential/recommended readings

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

Suggestive readings

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

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Artificial Intelligence and Machine Learning ELDSE-1A	4	3	-0	1	Course Admission Eligibility	Basic knowledge of Python language

Learning Objectives

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

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

UNIT – I (11 Hours)

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

UNIT – II (11 Hours)

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

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

UNIT – III (11 Hours)

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

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

UNIT – IV (12 Hours)

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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

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

Essential/recommended readings

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

Suggestive readings

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algorithm Design and Analysis ELDSE-1B	4	3	0	1	Course Admission Eligibility	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (11 Hours)

Data Structures: Stacks, array implementation of stack, operation on stacks, application of stacks-conversion of infix expression to prefix and postfix, evaluation

of expression; Queues, array implementation of queues, operation on queues, Linked List and its implementation of stack and queue.

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

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

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

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

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

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

Essential/recommended readings

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

Suggestive readings

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

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematics Foundation for Computing ELDSE-1C	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Basic Knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (12 Hours)

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

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

UNIT – II (10 Hours)

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

UNIT – III (11 Hours)

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

UNIT – IV (12 Hours)

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

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

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

Essential/recommended readings

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

Suggestive readings

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

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

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

GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Circuits and Interfacing ELGE-3A	4	3	0	1	-	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (12 Hours)

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

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

Comparators: Basic comparator, Schmitt Trigger.

UNIT – II (11 Hours)

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

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

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

UNIT – III (11 Hours)

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

UNIT – IV (11 Hours)

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

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

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

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

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

Essential/recommended readings

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

Suggestive readings

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

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

GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Modelling and Simulation ELGE-3B	**4**	**3**	**0**	**1**	**12th Pass**	**Basic Knowledge of Python language**

Learning Objectives

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

UNIT – I (12 Hours)

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

UNIT – II (11 Hours)

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

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

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

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

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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

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

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

Essential/recommended readings

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

Suggestive readings

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

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

SEMESTER-IV

UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

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

Add the following:

Syllabi of Semester-IV, V and VI of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

SEMESTER -IV

DEPARTMENT OF ELECTRONIC SCIENCE

Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 10: Electrical Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electrical Technology	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Circuit Theory & Network Analysis (DSC-2, Sem I), Basic Instrumen-tation & Measure-ment Techniques (DSC-4, Sem II)

Learning Objectives

The Learning Objectives of this course are as follows:

The paper deals with Electrical and Electronic systems viz.; Working, construction and principle of DC and AC machines, transformers and polyphase circuits. The paper covers the related concepts such as control of speed, generation of Torque, various losses, efficiency and breaking mechanisms of various commonly used electromechanical systems such as stepper, induction and universal motors. The understanding of mathematical relations between the various parameters, imparts enough knowledge to optimize the output response under a given condition.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Discuss the working principle of a Transformer and analyze its specifications
- Understand the working of DC Machines, DC Generators and DC Motors
- Classify Induction motors into Polyphase and single phase motors and understand their working
- Evaluate the working of Synchronous generators and synchronous motors and their comparative study with induction motors

SYLLABUS OF ELDSC-10 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)

Transformers: Overview of types of transformers, EMF equation, Transformer Losses, No load operation, Operation under load, Phasor diagram, Equivalent circuit of transformer, Voltage regulation, Condition for maximum efficiency, All day efficiency, short circuit and open circuit tests.

Polyphase Circuits: Line and phase relations in three phase circuits.

DC Machines: Overview of Basic constructional features and physical principles involved in electrical machines, lap and wave connections.

UNIT – II (13 Hours)

D.C. Generators: Principle of operation, Concept of armature reaction and commutation, E.M.F. Equation, Methods of excitation, Characteristics of separately excited and Self excited (Shunt, Compound and Series) generators, Losses and efficiency.

D.C. Motors: Comparison of generator and motor action, Principle of operation, Back EMF, Maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors, Losses & efficiency, Three-point starter, Factors affecting speed of DC motors.

UNIT – III (12 Hours)

Poly Phase Induction Motors: General constructional features, Types of rotors, Rotating magnetic field (single phase, two phase and three phase), Ferrari's Principle, Production of torque, Slip, Starting Torque, Running Torque, Torque equation, Torque-slip characteristics (Breakdown Torque), factors affecting speed of Induction motor.

Single Phase Induction Motors: General constructional features, Study and applications: Split phase motors, Capacitor start & run motor, Reluctance Motor, Stepper Motor, Universal motor

UNIT – IV (10 Hours)

Synchronous Machines: Principle of operation and construction features of Alternators (synchronous generators), E.M.F. equation, Principle of synchronous motor, methods of starting, Power developed in Synchronous motor, factors for failure to start, applications, comparison of synchronous and induction motor

Practical component (if any) – Electrical Technology

(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the working of DC series, shunt and Induction motors
- Study the working of transformer
- Study of Stepper motor, Universal motor
- Write a technical report on the experiment performed.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study of characteristics of DC Series motor.
2. Study of characteristics of DC Shunt motor.
3. Study of control of DC motor using SCR.
4. Study of characteristics of single-phase induction motor.
5. Study of Stepper motor.
6. Study of Universal motor.
7. Study of Open Circuit Test on single phase transformer.
8. Study of Short Circuit Test on single phase transformer.

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

Essential/recommended readings

1. B.L. Thareja, A.K. Thareja, A Textbook of Electrical Technology-Vol-II, S.Chand
2. J.B. Gupta, Electrical Technology (Electrical Machines), Katsons
3. I. J. Nagrath and D. P. Kothari, Electrical Machines, Tata McGraw Hill
4. H. Cotton, Advanced Electrical Technology, CBS Publishers and Distributors, New Delhi
5. S. Ghose, Electrical Machines, Pearson Education

Suggestive readings

1. G. Mc. Pherson, An introduction to Electrical Machines & Transformers, John Wiley & Sons
2. N. K. De and P. K. De, Electric Drives, Prentice Hall of India

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

DISCIPLINE SPECIFIC CORE COURSE – 11: Microprocessor

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Microprocessor	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Digital Electronics (DSC 5, Sem II)

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand basic architecture of 8085 microprocessor.
- To understand the instruction set and write programs in assembly language.
- To interface 8085 microprocessor with common Programmable Peripheral Devices.
- To understand the differences in the architecture and addressing modes of 8 bit and 16 bit Microprocessor.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic blocks of microcomputers i.e. CPU, Memory, I/O and architecture of microprocessors.
- Acquiring skills in writing assembly language program for 8085 microprocessor.
- Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory, I/O and programmable peripheral interface devices with 8 bit microprocessor.
- Derive specifications of an 8 bit microprocessor based system as per required application.

SYLLABUS OF ELDSC-11 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to Microprocessor: Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used)

Microprocessor 8085: Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.

UNIT – II (12 Hours)

8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.

UNIT – III (11 Hours)

Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay.

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts.

UNIT – IV (11 Hours)

Programmable Peripheral Interface (PPI): 8255- I/O interface, 8253/8254- Timer interface, 8259- Priority Interrupt Controller.

Designing of a microprocessor based system: Traffic Light Controller using PPI.

Comparison of 8085 Microprocessor with 8086 Microprocessor (Internal Architecture, Data Addressing Mode).

Practical component (if any) – Microprocessor

(Hardware and Assembly Language)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Proficient in use of IDE's for designing, testing and debugging microprocessor based system.
- Interface various I/O devices and design and evaluate systems that will provide solutions to real-world problem.

- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

8085 Assembly language programs:

1. Program to transfer a block of data.
2. Program for multibyte addition/subtraction.
3. Program to multiply two 8-bit numbers.
4. Program to divide a 16 bit number by 8 bit number.
5. Program to search a given number in a given list.
6. Program to generate terms of Fibonacci series.
7. Program to find minimum and maximum among N numbers.
8. Program to find the square root of an integer.
9. Program to find GCD of two numbers.
10. Program to sort numbers in ascending/descending order.
11. Program to verify the truth table of logic gates.
12. Interfacing using PPI 8255/8253/8259.

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

Essential/recommended readings

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, Wiley Eastern Limited- IV Edition.
2. 8085 Microprocessor : Programming and Interfacing, N. K SRINATH, PHI Learning(2014).

Suggestive readings

1. 8085 Microprocessor and its Applications, A Nagoor Kani, Tata Mcgraw Hill, Third Edition.

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

DISCIPLINE SPECIFIC CORE COURSE – 12: Communication Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Communication Systems	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Circuit Theory & Network Analysis (DSC-2, Sem I), Analog Electronics-I(DSC-6, Sem II) and Signals & Systems (DSC-9, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce concepts of various analog modulation techniques used in communication systems and analyse their comparative performance.
- To understand Pulse analog modulation and Pulse digital transmission techniques

Learning outcomes

The Learning Outcomes of this course are as follows:

- Be conversant with the requirements and the protocols employed in the fundamental components of a communication network.
- Understand the concept and basic circuits used in Continuous Wave analog modulation
- Understand the Principles of Sampling and Pulse Communication
- Insight on Digital Transmission.

SYLLABUS OF ELDSC-12 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals. Block diagram of Transmitter and Super Heterodyne Receiver. Concept of Noise and Signal to noise ratio.

UNIT – II (11 Hours)

Amplitude Modulation: Concept of modulation index and frequency spectrum and Power Relations in AM. Generation of AM by Square Law and Collector Modulator, Diode Detection, Concept of Double side band suppressed carrier, Single side band suppressed carrier by Filter Method, Pilot Carrier Modulation, Vestigial Side Band modulation, and Independent Side Band Modulation.

UNIT – III (11 Hours)

Angle modulation: Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (Block diagram of direct and indirect methods), FM detector (PLL). Concept of Pre-emphasis and De-emphasis. Comparison between AM, FM and PM.

UNIT – IV (12 Hours)

Pulse Analog Modulation: Sampling theorem, Aliasing and Aperture Effect, PAM, PWM, PPM -Generation and detection techniques, Multiplexing-TDM and FDM.

Pulse Code Modulation: Need for digital transmission, Block Diagram of PCM, Uniform and Non- uniform Quantization, Quantization Noise, Companding, Line Coding. Introduction to Delta Modulation and DPCM.

Practical component (if any) – Principles of Communication Systems
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basic elements of a communication system.
- Analyse the baseband signals in time domain and in frequency domain.
- Build understanding of various analog (CW) and Pulse modulation and demodulation techniques
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

The practical needs to be performed on Scilab/ MATLAB/Multisim or any other equivalent software besides hardware.

1. Study of Amplitude Modulation.

2. Study of Frequency Modulation.
3. Study of AM Transmitter and Receiver.
4. Study FM Transmitter and Receiver.
5. Study of Pulse Amplitude Modulation
6. Study of Pulse Width Modulation
7. Study of Pulse Position Modulation.
8. Study of Pulse Code Modulation
9. Study of Delta Modulation

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

Essential/recommended readings

1. Electronic Communication Systems Fourth Edition by George Kennedy and Bernard Davis.
2. Principles of Electronic Communication Systems Second Edition by Taub and Schilling.
3. Electronic Communication Systems Fifth Edition by Wayne Tomasi.

Suggestive readings

1. Principles of Electronic Communication Systems by Louis E. Frenzel
2. Communication Systems (Analog and Digital) by R.P.Singh and S.D.Sapre

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Internet of Things	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Digital Electronics (DSC-5 , Sem II) , Basic Instrumentation & Measurement Techniques (DSC-4, Sem 2)

Learning Objectives

This course describes the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Broad objectives are:

- To introduce the terminology, technology and its applications
- To introduce the concept of M2M (machine to machine) with necessary protocols
- To introduce the Python Scripting Language commonly used in IoT devices/systems
- To introduce the Arduino / Raspberry Pi platform, widely used in IoT applications
- To introduce the implementation of web-based services on IoT devices

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand internet of Things, its hardware and software components and the IoT value chain structure (device, data cloud).
- Interface I/O devices, sensors & communication modules.

- Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules
- Remotely monitor data and control devices and develop real life IoT based projects.

SYLLABUS OF ELDSE-2A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to Internet of Things - Definition and Characteristics of IoT, Architectural overview (cellular, star, mesh, ring)

Physical design of IoT: Things in IoT, IoT protocols in Link Layer, Network/Internet Layer, Transport Layer, Application Layer (with specific reference to Communication protocols as MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP, WebSocket etc.,), Basics of Networking, Security aspects in IoT.

Logical design of IoT: Functional blocks, Communication Models, Communication APIs, Enabling Technologies, IoT levels and deployment templates, Design principles IoT and M2M- Definitions, differences between M2M & IoT systems, Software defined networks (SDN), network function virtualization (NFV), difference between SDN and NFV for IoT, Basics of IoT System Management with SNMP, NETCONF -YANG

UNIT – II (11 Hours)

Transducers, Sensors and Actuators: Review of Transducers, Concept of Sensing and Actuation, Sensor characteristics (static/dynamic), Sensor classification (passive/active, analog/digital, scalar/vector), Actuator classification (Electric/Fluid Power/ Linear Chain /Manual / Linear vs Rotary)

Types of Sensors: Contact and Proximity, Position, Velocity, Force, Humidity, Tactile unipolar and bipolar Stepper motors Sensors- Light sensor, temperature sensor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor etc.

Selection of Transducers for various IoT applications, Wireless Sensor Networks

UNIT – III (12Hours)

Computing (using Arduino, Raspberry Pi), I/O interfaces.

Software components- Programming API's (using Python/Node.js/Arduino). Introduction to Arduino/Raspberry Pi- Installation, Interfaces (serial, SPI, I2C)

Raspberry Pi: Communication with devices through the pins of the Raspberry Pi, RPi. GPIO library, Python Functions, setting up the pins, General purpose IO Pins, Protocol Pins, GPIO Access, applying digital voltages, and generating Pulse Width Modulated signals, Tkinter Python library, accessing pins through a graphic user interface

OR

Arduino: Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Arduino board main components, inputs, and outputs. Arduino Integrated Development Environment (IDE), Compiling Code, Arduino Shields and Libraries.

Basics of C programming, composition of an Arduino programs, Arduino tool chain, Arduino IDE, basic structure of a sketch, including the use of the setup() and loop() functions. Accessing the pins from a sketch for input and output, introduction on debugging embedded software on an Arduino, UART communication protocol, Synchronization, parity and stop, the use of the Serial library to communicate with the Arduino through the serial monitor.

Programming – Python programs with Arduino/Raspberry Pi with focus on interfacing external gadgets, controlling output, reading input from pins

Note: It is optional to choose either Arduino or Raspberry Pi environment

UNIT – IV (11 Hours)

IoT Physical Devices and Endpoints, Domain specific IoTs, IoT Physical Servers and Cloud Offerings

Cloud Computing: Characteristics, Introduction to Cloud Service models (SaaS, PaaS, IaaS, XaaS etc.,) Deployment models, Cloud storage APIs, IoT-Cloud convergence, Communication Enablers

Webservices – Web server for IoT, Python-Web frameworks, RESTful Web API, ThingSpeak API, MQTT, IoT security, Basics of symmetric and non-symmetric encryption standards

IoT Application Development - Solution framework for IoT applications-Implementation of Device integration, Data acquisition and integration

Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies based on Smart Environment, Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Practical component (if any) – Internet of Things

Learning outcomes

The Learning Outcomes of this course are as follows:

- Interfacing of various sensors using Arduino/Raspberry Pi
- Interfacing using Bluetooth, Web server, TCP, ThinkSpeak Cloud, MQTT broker

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

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.

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

Essential/recommended readings

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895
5. Adrian McEwen, "Designing the Internet of Things", Wiley

Suggestive readings

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 Editors Ovidiu Vermesan
2. Peter Friess,'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
3. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Operating Systems	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Programming Fundamentals using Python (DSC-1, Sem I)/ Algorithm Design and Analysis(DSE-1B, Sem III)

Learning Objectives

COURSE OVERVIEW: Operating systems course is intended as a general introduction to the techniques used to implement operating systems and related kinds of systems software. The topics covered will be functions and structure of operating systems, process management (creation, synchronization, and communication); processor scheduling; deadlock prevention, avoidance, and recovery; main-memory management; virtual memory management (swapping, paging, segmentation and page-replacement algorithms); control of disks and file-system structure and implementation.

The Learning Objectives of this course are as follows:

- To explain main components of OS and their working
- To familiarize the operations performed by OS as a resource Manager
- To introduce various scheduling policies of OS.
- To teach the different memory management techniques.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn multiprogramming, multithreading concepts for a small operating system.
- Create, delete, and synchronize processes for a small operating system.
- Implement simple memory management techniques.
- Implement CPU and disk scheduling algorithms.
- Use services of modern operating system efficiently

- Learn basic file system.

SYLLABUS OF ELDSE-2B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Overview: Introduction, Computer-System Organization and Architecture, Multiprocessor and Clustered Systems, OS Operations, Multiprogramming and Multitasking, Resource management- process management, memory management, file-system management, Mass- storage management, I/O System management systems, protection and security. Virtualization, Distributed systems, Real Time Embedded Systems, Free and Open source Operating systems and Operating system services.

UNIT – II (12 Hours)

Process management: Basic concepts, Scheduling Criteria, Scheduling algorithms- FCFS, SJF, Priority, RR and Multilevel Queue. Process synchronization.

Concurrency and Synchronization: The Critical-section problem, Semaphores, Deadlock Characterization, Prevention, Avoidance, Detection and Recovery.

UNIT – III (12 Hours)

Memory management: Basic hardware, Address binding, Physical and Logical address space, Swapping, Memory allocation strategies -Fixed and Variable Partitions, Fragmentation, Paging, Segmentation, Demand Paging and virtual memory, Page Replacement Policies - FIFO, OPR, LRU.

UNIT – IV (10 Hours)

File system: Concept of a file, access methods, directory structure, file system mounting, file sharing, protection, file system structure, file system implementation, Directory implementation, allocation methods, free-space management, efficiency and performance, Disk scheduling algorithms- FCFS, SSTF, SCAN and C-SCAN.

Practical component (if any) – Operating Systems
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement various process scheduling algorithms
- Implement various priority based scheduling algorithms
- Implement various page replacement algorithms
- Implement various disk scheduling algorithms

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Write a program to implement FCFS scheduling algorithm.
2. Write a program to implement Round Robin Process scheduling algorithm.

3. Write a program to implement SJF Process scheduling algorithm.
4. Write a program to implement non-preemptive priority-based scheduling algorithm.
5. Write a program to implement preemptive priority-based scheduling algorithm.
6. Write a program to implement SRJF scheduling algorithm.
7. Write a program to implement first-fit, best-fit and worst-fit allocation strategies.
8. Write a program to implement FIFO Page replacement algorithm.
9. Write a program to implement OPR Page replacement algorithm.
10. Write a program to implement LRU Page replacement algorithm.
11. Write a program to implement SCAN Disk Scheduling algorithm.
12. Write a program to implement SSTF Disk Scheduling algorithm.

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

Essential/recommended readings

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating Systems Concepts", Tenth Edition, John Wiley & Sons, 2018, ISBN:978-1-118-06333-0.
2. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.

Suggestive readings

1. Andrew S Tanenbaum, Herbert Bos "Modern Operating Systems" , Fourth Edition, Pearson Education India, 2016. ISBN 978-9332575776.
2. William Stallings, "Operating Systems Internals and Design Principles", Seventh Edition, Pearson Education, 2018. ISBN 978-9352866717.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", Third Edition, Pearson Education.
4. Deitel & Deitel (2008), Operating systems, 3rd edition, Pearson Education, India
5. Achyut S Godbole, Atul Kahate, "Operating Systems", 3rd Edition, Tata McGraw Hill, 2011.

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

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DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Network Synthesis	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Circuit Theory & Network Analysis (DSC-2, Sem I), Engineering Mathematics DSC(7, Sem III)/Signals and Systems (DSC-9, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic frequency domain techniques and two port network parameters.
- To study the elements of network synthesis.
- To study and synthesise the one port networks with two kinds of elements.
- To study the synthesis of transfer function.
- To study and design the filters

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of frequency domain techniques and two port network parameters.
- Understand the basic concepts of network synthesis.
- Synthesise the one-port networks and transfer function.
- Determine the frequency response of filters.

SYLLABUS OF ELDSE-2C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Circuit Analysis: Concept of Poles and Zeros in complex frequency/s-plane, Initial and Final Value Theorem, Representation of Circuit Elements in s-domain, Circuit Analysis using Laplace Transform Method, The System Function for R-C and R-L Networks and their Impulse and Step Responses.

Two Port Network Parameters: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters, Hybrid (h) Parameters.

UNIT – II (10 Hours)

Elements of Network Synthesis: Causality and Stability, Hurwitz Polynomial, Sturm's Theorem, Positive Real Functions, Basis Synthesis Procedures.

UNIT – III (11 Hours)

Synthesis of One Port Networks with Two Kinds of Elements: Properties of L-C Immittance Functions, Synthesis of L-C Driving-Point Immittances, Properties of R-C Driving Point Impedances, Synthesis of R-C Impedances or R-L Admittances, Properties of R-L Impedances and R-C Admittances, Synthesis of R-L-C Functions.

UNIT – IV (12 Hours)

Transfer Function Synthesis: Properties of Transfer Functions, Synthesis of L-C Ladder Network with a 1-ohm Resistive Termination, Synthesis of Constant-Resistance Networks (Bridge and Lattice Type).

Filter Design: Ideal Filters, Low Pass Filter Design using Butterworth and Chebyshev approximation and Comparison between them.

Practical component (if any) – Network Synthesis
(Hardware/Software/Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Verify the operation and response of typical electrical circuits.
- Determine the various parameters for two-port networks.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Mesh and Node Analysis of circuits using AC Sources.
2. Computation and plot of Poles, Zeros and Stability of a Function.
3. Study of step response of RC Network.

4. Study of step response of RL Network
5. Computation and plot of Inverse-Laplace Transform of a Function.
6. Determination of Impedance (Z) and Admittance (Y) parameters of Two-Port Network.
7. Determination of ABCD Parameters of Two-Port Network.
8. Determination of Hybrid (h) Parameters of Two-Port Network.
9. Designing of a Low Pass Filter (Butterworth Approximation) and study of its Frequency Response.
10. Designing of a Low Pass Filter (Chebyshev Approximation) and study of its Frequency Response.

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

Essential/recommended readings

1. Kuo, F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India (2013).
2. M. E. Van Valkenburg, "Introduction to Modern Network Synthesis", Wiley Eastern (1984).

Suggestive readings

1. Aatre, V. K., "Network Theory and Filter Design", 3rd Ed., New Age International (2014).

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GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Instrumentation	4	3	-	1	Class XII passed with Maths/Applied Maths	Idea about basic circuit elements like R, C and L, Ammeter, Voltmeter

Learning Objectives

The Learning Objectives of this course are as follows:

- Explain the importance and working principle of different electronic measuring instruments.
- Use the complete knowledge of various instruments and transducers to make measurements in the laboratory.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with the working principle of different measuring instruments
- Understand measuring instruments used in the laboratory like oscilloscopes, signal generators
- Understand working principle of transducers
- Familiarize with the working principle of data acquisition devices and biomedical instruments.

SYLLABUS OF ELGE-4A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (10 Hours)

DC and AC indicating Instruments: Accuracy and precision, Types of errors, PMMC galvanometer, sensitivity, Loading effect , Conversion of Galvanometer into ammeter, Voltmeter and Shunt type ohmmeter, Multimeter.

UNIT – II (12 Hours)

Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, DSO :Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, risetime).

Signal Generators: Function generators.

UNIT – III (10 Hours)

Transducers: Basic requirements of transducers, Transducers for measurement of nonelectrical quantities: Types and their principle of working , measurement of Linear displacement, Acceleration, Flow rate, Liquid level, strain, Force, Pressure, Temperature.

UNIT – IV (13 Hours)

Data acquisition systems: Block diagram, brief description of preamplifier, signal conditioner, instrumentation amplifier, A/D and D/A converter blocks, computer-controlled test and measurement system.

Bio-medical instrumentation: Bio-Amplifiers: Different types of Bio-OP-Amps, Electrodes for ECG , block diagram of ECG system, brief analysis of graphs.

Practical component (if any) – Instrumentation
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- To measure various electrical parameters.
- To measure characteristics of various sensors and transducers.
- Understand ECG pattern.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Design of ammeter and voltmeter using galvanometer.
2. To determine the Characteristics of resistance transducer - Strain Gauge
3. To determine the Characteristics of LVDT.
4. To determine the Characteristics of Thermistors and RTD.
5. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.

6. Characterization of bio potential amplifier for ECG signals.
7. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
8. Study of pulse rate monitor with alarm system.

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

Essential/recommended readings

1. Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
2. Handbook of biomedical instrumentation: Khandpur R S, TMH
3. Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
4. Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.
5. Mechatronics – principles and applications, Godfrey C Onwubolu, Elsevier, 2006

Suggestive readings

1. Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies
2. Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
3. Instrumentation devices and systems: Rangan, Sarma, Mani, TMH
4. Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH

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GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mobile Application Development	4	1	-	3	Class XII passed in any stream	Idea about the Computer System Configuration like processor, RAM, ROM, different Operating Systems etc.

Learning Objectives

In this course, student will be developing foundational programming skills to support graphical element presentation and data manipulation from basic functions through to advance processing. You will continue to build your skill set to use and apply core graphics, touch handling and gestures, animations and transitions, alerts and actions as well as advanced algorithms, threading and more. By the end of this course, you will be able to develop a more advanced, fully functioning app. currently this course is taught using Flutter UI SDK.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the concepts on: Elements of user interface, Model-View-Controller architecture, Data persistence and storage, Multithreading, Mobile web vs. mobile app, Services, broadcasts and notifications, Sensor management and location-based services.
- Describe different mobile application models/architectures and patterns.
- Familiarize with data type, data operators, exception handling and file management
- Describe the components and structure of a mobile development framework (Flutter SDK) in the development of a mobile application

SYLLABUS OF ELGE-4B Total Hours- Theory: 15 Hours, Practicals: 90 Hours

UNIT – I

Introduction: What is mobile Application Programming, Different Platforms, Architecture and working of Android, iOS and Windows phone 8 operating system, Comparison of Android, iOS and Windows phone 8.

About Flutter: Understanding Flutter, Flutter framework, Introduction to Android studio, Flutter SDK - Installing and Configuring, Introduction to Dart writing Dart code, Dart Pad, Installing Dart SDK.

UNIT – II

Basic DART Programming Concepts: Introduction, Main () function, Dart variables, Dart Data Types, Dart Conditional Operators: - if- Else statements, Loop operators, Break statements, switch case statements.

Dart Functions & Object -Oriented Programming: Functions- its structure, creating a function, function Return Data Types, Void function, variable scope, OOP- Objects and classes, creating a Class, Adding Methods to classes, Providing constructors for classes, Class – Getters and Setters, Class Inheritance, Abstract Class, Dart Project Structure and Dart Libraries.

UNIT – III

Flutter Widgets Fundamentals: Scaffold, Image, Container, Column and Row, Icon Widgets, Layouts, Card Widgets, App Icon for iOS and Android apps, Hot reload and Hot Restart, Stateful and Stateless Widgets, Using custom Font.

Navigation and Routing: Button, Floating Action Button

Visual, Behavioral and Motion- Rich Widgets Implementation: Bottom Navigation Bar, ListTile, ListView, Drawer, DataTable, Selectable Text, Stack, Input and Selections, Text field, Checkbox group and Radio Button, Date Picker, Time Picker, Slider, Switch, Dialogs, Alerts and Panels.

UNIT – IV

App testing & Publishing: Testing and feedback for your App, setting up a test environment, Usability Testing, starting your Test Session, Analyzing your Test, Publishing Flutter Apps, Publishing Android App on Google Play store.

Understanding Flutter Versions, Flutter macOS Setup, macOS development Environment, Publishing iOS app on Apple store.

Practical component (if any) – Mobile Application Development
(Flutter and Dart Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Proficient in use of IDE's for designing and development of various android based applications.
- Design and developed various applications using various components GUI component, GPS, SD card.
- Prepare the technical report on the projects carried

LIST OF PRACTICALS (Total Practical Hours- 90 Hours)

1. Develop an application that uses GUI components, Font and Colors.
2. Develop an application that uses Layout Managers and event listeners.
3. Develop a native calculator application.
4. Write an application that draws basic graphical primitives on the screen.
5. Develop an application that makes use of database.
6. Implement an application that implements multi-threading.
7. Develop a native application that uses GPS location information.
8. Implement an application that writes data to the SD card.
9. Implement an application that creates an alert upon receiving a message.
10. Write a mobile application that creates alarm clock.
11. Develop an application for working with Menus and Screen Navigation.
12. Develop an application for working with Notifications

List of Projects: -

1. Counter App
2. Calculator App
3. Audio recorder App
4. Voice to text Converter
5. Tic-tac-toe Game

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

Essential/recommended readings

1. Flutter for Beginners: A Genius guide to flutter App development, Edward Thornton.
2. Beginning App Development with Flutter Book, Rap Payne.
3. Quick Start Guide to Dart Programming, Sanjib Sinha, Apress Publication.
4. Dart Apprentice: Beginning Programming with Dart, Jonathan Sande and Matt Galloway.

Suggestive readings

1. Flutter Complete Reference: Create beautiful, fast and native apps for any device, Alberto Miola.
2. Beginning Flutter: A Hands-on Guide to App Development, Marco L. Napoli.

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SEMESTER-V

UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

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

Add the following:

Syllabi of Semester-IV, V and VI of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

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SEMESTER-V
DEPARTMENT OF ELECTRONIC SCIENCE
Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 13: Embedded System

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Embedded System	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Microprocessor (DSC 11, Sem IV)

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to the fundamental understanding of an embedded system. It is designed to make student familiar with the features, architectures and design issues involved in embedded system. The course focuses both on hardware and software components. Important serial communication protocols are also included. Syllabus covers microcontroller programming in C, which is platform independent.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the fundamental concepts and features related to embedded systems .
- Understand the AVR RISC architecture and Instruction set.
- Interface I/O devices with microcontroller using parallel ports, serial ports, ADC etc.
- Learn the concepts of hardware & software interrupts and Timer

- Design simple embedded systems including their hardware as well as software.

SYLLABUS OF ELDSC-13 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction: Overview of Embedded Systems, Requirements and Applications, Introduction to microcontrollers, Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers.

AVR Microcontroller: ATMega32 AVR RISC microcontroller architecture, Status Register, General Purpose Register file, Program memory and data memory organisation, Reset sources (Power-on, Brownout & Watchdog Timer).

UNIT – II (11 Hours)

Instruction Set: Addressing Modes, Data Transfer Instructions, Arithmetic and Logic Instructions, Branch Instructions, Bit and Bit-test Instructions, MCU Control Instructions., Introduction to AVR Programming in C, C datatypes, operators for AVR, simple programs for control, loop, arithmetic & logical operations and bit manipulation.

UNIT – III (12 Hours)

Peripheral I: Configuring I/O ports, Pull-up resistors, reading and writing data to I/O ports. Introduction to Interrupts, interrupt vector address and priority, ISR, External Interrupts. Introduction to Timers, Timers as delay generators and event counters, Timer0 modes of operation.

UNIT – IV (11 Hours)

Peripheral II: Analog-to-Digital Converter (ADC), Basics of Serial Communication, Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART), Serial Peripheral Interface (SPI), Two Wire Interface (TWI) / I2C bus.

Practical component (if any) – Embedded System

(Hardware and AVR studio or similar IDE Software)

(Students are required to perform listed experiments and make a Mini Project)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to program AVR microcontrollers using AVR studio/similar IDE.
- Learn different interfacing techniques and standards to control various input output devices with the microcontroller.
- Student will be equipped with sufficient knowledge to implement mini projects.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. (i) Blink LED at a constant rate.
   (ii) Blink LED at linearly increasing rate until the LED appears always on.
2. Use LFSR (linear feedback shift register) based random number generator to generate a random number and display it.
3. To interface 4 Keys with Port A and Port B each. Write a program to read the data from Port A and Port B and display its sum (and other arithmetic & logical operations) on output device.
4. To interface a LED/Buzzer with an o/p pin of AVR microcontroller. Write a program to blink the LED / Beep the Buzzer at (i) a constant rate (ii) linearly increasing rate using Timer.
5. To interface a 4x4 Keypad/push button keys with I/O pins of AVR microcontroller. Write a program to display the number of the key pressed in Binary number format on LED array or decimal number format on 7-segment LED or text display on an LCD or Serial Monitor.
6. To interface a potentiometer with ADC of AVR microcontroller. Write a program to display the dc input voltage on an output device (LED array / 7-segment LED / LCD / Serial Monitor).
7. To control the intensity of an LED/pitch of buzzer using PWM mode of Timer 0.
8. To interface a DC motor or Stepper motor and to write a program to control its speed.

Mini Project

(Any one of the following mini project or on similar concepts incorporating data acquisition from sensors/ input device, data analysis & control and display of result on any output device) (individual project only)

Project Idea 1: Weather Monitoring System -
Input - Temperature, humidity, wind speed etc.
Output - Display instantaneous values, average value, MAX / MIN value and predicted value for the next hour

Project Idea 2: Electronic Voting Machine -
Input - 8 Voting keys, Control Keys (Master Clear, Display Result, etc)
Output - Display device showing instructions, messages and results in accordance to the key pressed

Project Idea 3: Health Monitoring System -
Input – Pulse rate, Blood Pressure, SpO2, etc.
Output - Display device showing results

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

Essential/recommended readings

1. "AVR Microcontroller and Embedded Systems: Using Assembly and C", Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, PHI,2013
2. "Programming and Customizing the AVR Microcontroller", D V Gadre, McGraw- Hill,2000
3. "Atmel AVR Microcontroller Primer: Programming and Interfacing", Steven F. Barrett, Daniel J. Pack, Morgan & Claypool Publishers,2012
4. "Embedded system Design", Frank Vahid and Tony Givargis, John Wiley, 2002

Suggestive readings

1. "An Embedded Software Primer", David E Simon, Addison Wesley,1999
2. AVR Microcontroller Datasheet, Atmel Corporation, www.atmel.com

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DISCIPLINE SPECIFIC CORE COURSE – 14: Electromagnetics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electromagnetics	4	3	-	1	Class XII passed with Physics + Mathematics/ Applied Mathematics + Chemistry OR Physics + Mathematics/ Applied Mathematics + Computer Science/ Informatics Practices	Engineering Mathematics (DSC 7, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:
The syllabus of the paper is very carefully framed with the objective to well verse the students of the programme about

- Ability to apply knowledge of mathematics in solving electromagnetic problems.
- To understand the concept of electromagnetic waves in low frequency and high frequency applications.
- This paper is the backbone in the development of new integrated devices and applications of electromagnetic principles in various allied disciplines such as communications, microwaves, radar, electromagnetic interference & electromagnetic compatibility, remote sensing and fibre optics.
- Basic laws of electromagnetics required for any student who wants to pursue his career in research

Learning outcomes

The Learning Outcomes of this course are as follows:

- Getting familiar with vector algebra, coordinate system and coordinate conversion
- Understanding electrostatic fields and magnetostatic fields.
- A balanced presentation of static and time-varying fields.

- Physical interpretation of Maxwell's equation and problem solving in different media
- Understanding of propagation of an electromagnetic wave.

SYLLABUS OF ELDSC-14 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (14 Hours)

Vector Analysis: Scalars and Vectors, Vector Algebra, Rectangular (Cartesian) Coordinate System, Vector Components and Unit Vector, Vector Field, Products, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector ,Divergence and Stokes Theorem, the Laplacian.

Electrostatic Fields: Coulomb's Law and Electric Field, Electric Potential, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation, Electric dipole. Electric Fields in Conductors, Current and Current Density, Continuity of Current, Metallic Conductor. Dielectric materials, Polarization in Dielectrics, Dielectric Constant, Isotropic and Anisotropic dielectrics. Electrostatic Energy, Boundary Condition, Poisson equation and Laplace equation, Uniqueness Theorem.

UNIT – II (10 Hours)

Magnetostatics: Biot Savert's law, Magnetic dipole, Ampere's Circuital Law, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic materials. Magnetic Energy, Boundary Conditions

UNIT – III (10 Hours)

Time-Varying Fields and Maxwell's Equations: Faraday's Law of Electromagnetic Induction, stationary and moving loop in time varying magnetic field, Displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations. Time varying potential, Lorentz condition for potential. Wave Equation for Potentials. Time Harmonic Electromagnetic Fields and use of Phasors

UNIT – IV (11 Hours)

Electromagnetic Wave Propagation: The Electromagnetic Spectrum, Wave Equation in a source free isotropic homogeneous media, Uniform Plane Waves propagation in Lossless and Lossy unbounded homogeneous media, Plane Wave Propagation in Good conductor, wave Impedence, Skin Depth and skin effect, Wave Polarization: Linear, elliptical and Circular. Flow of Electromagnetic Power and Poynting Vector.

Practical component (if any) – Electromagnetics
(using Scilab/MATLAB/ any other similar freeware)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the plotting of vectors, and transformation among various coordinate systems in 2D and 3D.
- Understand the graphical representation of scalar and vector fields including gradient, divergence and curl.
- Understand the graphical representation of electric and magnetic fields for various types of charge and current distributions respectively.
- Understand the flow of energy and power associated with electromagnetic waves.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Understanding and Plotting Vectors.
2. Point to point and Vector Transformation from Cartesian to cylindrical co-ordinate system and vice versa.
3. Point to point and Vector Transformation from Cartesian to Spherical co-ordinate system and vice versa.
4. Point to point and Vector Transformation from Cylindrical to Spherical co-ordinate system and vice versa.
5. Representation of the Gradient of a scalar field, Divergence and Curl of Vector Fields.
6. Plots of Electric field due to charge distributions.
7. Find the Magnetic field from a given Electric field for a Uniform plane wave.
8. Find a Poynting Vector for a given electromagnetic field at a given point.

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

Essential/recommended readings

1. Murray. R. Spiegel, Vector Analysis, Schaum series, Tata McGraw Hill (2006)
2. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
3. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
4. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
5. Introduction to Electrodynamics, D.J. Griffiths, Pearson Education (2012)
6. Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)

Suggestive readings

1. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
2. W. H. Hayt and J. A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)

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

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- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

DISCIPLINE SPECIFIC CORE COURSE – 15: Basic VLSI Design

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic VLSI Design	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semiconductor Devices(DSC 3, Sem I), Digital Electronics(DSC 5, Sem II)

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to basic principle of MOS Transistor operation, SPICE model, MOS transistor and Inverter layout, CMOS layout, Inverter design, CMOS inverter, inverter characteristics and specifications. Static and Sequential MOS Logic design, pass transistor logic, static & dynamic latches, flip flops, static & dynamic registers, Monostable sequential circuits. MOS memory design, RAM & ROM cells, Logic families performance.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the concept of models of MOS devices and their implementation in designing of CMOS inverter
- Measure the performance parameters like threshold voltage, noise margins, time delays etc.
- Familiarize with the techniques and components involved in combinational MOS circuit designs.
- Describe the various types of semiconductor memories and issues involved in them

SYLLABUS OF ELDSC-15 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Metal Oxide Semiconductor (MOS): Introduction to basic principle of MOS transistor, large signal MOS models (long channel) for digital design. MOS SPICE model, MOS Transistor layout(PMOS and NMOS)

UNIT – II (12 Hours)
MOS Inverter: Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, Dynamic behaviour, Propagation Delay and Power Consumption.

UNIT – III (11 Hours)
Combinational MOS Logic Design: Static MOS design, Pass Transistor logic, complex logic circuits.
Sequential MOS Logic Design - Static latches, Flip flops & Registers, Dynamic Latches & Registers, Monostable sequential circuits.

UNIT – IV (10 Hours)
Memory Design: ROM & RAM cells design. Dynamic MOS design- Dynamic logic families and performances.
Design for testability: Introduction, Fault types and models, Controllability and observability, AdHoc Testable design techniques, Scan –based techniques.

Practical component (if any) – Basic VLSI Design
(PSpice/other Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Reproduce the characteristics of digital circuits like inverter and other logic gates based on CMOS technology.
- Design the digital circuit components like latches, multiplexers etc.
- Perform experiments and the circuit design and collect and analyse the data
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To plot the (i) output characteristics & (ii) transfer characteristics of an n-channel and p-channel MOSFET.
2. To design and plot the static and dynamic characteristics of a digital CMOS inverter.
3. To design and plot the output characteristics of a 3-inverter ring oscillator.
4. To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
5. To design and plot the characteristics of a 4x1 digital multiplexer using pass-transistor logic.
6. To design and plot the characteristics of a positive and negative latch/master-slave edge triggered registers based on multiplexers.

7. To prepare layout for given logic function and verify it with simulations.
   To measure propagation delay of a given CMOS Inverter circuit.

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

Essential/recommended readings

1. Weste and Eshraghian, —Principles of CMOS VLSI design, Addison-Wesley, 2002.
2. Basic VLSI design: Douglas A Pucknell, Kamran Eshraghian, PHI, 3rd edition

Suggestive readings

1. Kang & Leblebigi —CMOS Digital IC Circuit Analysis & Design- McGraw Hill, 2003.
2. Rabey, —Digital Integrated Circuits Design, Pearson Education, Second Edition, 2003.

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

This document is prepared from the following University Notifications

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- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Computer Networks	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Programming Language (DSC 1, Sem I)/ Algorithm Design and Analysis(DSE 1B, Sem III), Operating System(DSE 2B, Sem IV)

Learning Objectives

The course objectives include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience. This course introduces the student to the fundamental understanding of the architecture and principles of today's computer networks. It introduces various protocols and their functionalities. This course will help to understand The Internet and its impact on the computer network architecture.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describing computer network in terms of a layered model.
- Implementing data link, network, and transport layer protocols in a simulated networking environment
- Determine different types of errors and data flow within networks.
- Planning logical sub-address blocks with a given address block.
- Describing the standard protocols involved with the INTERNET, TCP/IP, based communications.

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- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

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

UNIT – I (11 Hours)

Network Basics and Physical layer: Data Communication- Components, Network topologies, OSI Reference Model, Internet (TCP/IP) Model, Digital Signals, Digital-to-Digital Encoding, Transmission Media- Guided and Unguided, Addressing, Transmission Impairment, Nyquist Bit rate, Shannon Capacity and Line Codling Schemes, Switching-Circuit Switching, Message Switching and Packet Switching, Network Connecting Devices- Repeaters, Hubs, Switches, Bridges, Routers and Gateway.

UNIT – II (12 Hours)

Data Link Layer and MAC: Character and Bit Oriented Framing, Flow and Error Control, Error Detection and Correction Codes- Parity, Hamming Code, Cyclic Redundancy Check and Checksum, Stop and Wait Protocol, Sliding Window Protocol and Piggybacking, Go-Back-N ARQ, Selective Repeat ARQ. Random Access Protocols-ALOHA, CSMA, CSMA/CD, CSMA/CA, Controlled Access Protocols- Reservation, Token Passing and Polling, Channelization Protocols-FDMA, TDMA and CDMA.

UNIT – III (12Hours)

Network Layer: IPV4 Addresses- Classful and Classless, Subnet Addressing, NAT, Datagram Format, Internet Control Protocols- ARP, RARP and ICMP, Routing algorithms - Shortest Path and Distance Vector, Approaches to Congestion Control, IPV4 issues, Need for IPV6,IPv6 Packet Format, IPV6 Unicast and Multicast Addressing

UNIT – IV (10 Hours)

Transport and Application Layer: Transport Services, Connection management, TCP and UDP protocols, Congestion Control and Quality of Service, Application Layer-DNS, FTP, WWW and HTTP.

Practical component (if any) – Computer Networks

(The practical will need to be Simulated on Cisco Packet Tracer or an equivalent platform. All Programming experiments to be done with Python)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement a simple network with hubs and switches.
- Understand the various LAN topologies
- Describe how packets are delivered in the Internet.
- Describe what classful addressing scheme is.
- Grasp the error detection and correction algorithms

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Create a simple network with a switch and two end devices in Cisco Packet Tracer. Configure the PCs, set their IP address and capture Ping from one PC to the other and vice versa.. Mention the uses of PING command.
2. Study Network Commands: tracert, ipconfig and ipconfig/all.
3. Implement MESH/STAR/RING/BUS topology in Packet tracer.
4. Write a program to add a parity bit to a 7 bit data input by a user/ add redundant bits to a 7 bit data using Hamming Code to be implemented at the sender's site.
5. Write a program to detect and correct a single bit error while transmitting a 7-bit Hamming Code word to be implemented on the receiver side.
6. Write a program to implement CRC at the sender's site.
7. Write a program to show Byte and Bit stuffing in a frame.
8. Set a six-computer network with a switch using Packet Tracer and show Unicast and Broadcast addressing.
9. Connect two different networks using a router in Packet tracer and show movement of packets from one to the other.
10. Write a program to determine the class of the given IPV4 Address in Dotted Decimal or Binary Notation.
11. Implement FTP Server in Packet Tracer and show transfer of data.
12. Study HTTP /DNS on the Packet Tracer.

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

Essential/recommended readings

1. Behroz A. Forouzan, " Data Communication and Networking", TMH, 5th Edition.
2. A.S.Tanenbaum, " Computer Network", Pearson Education, 4th Edition.

Suggestive readings

1. James Kurose , "Computer Networking: A Top-Down Approach", Pearson Education, 7th Edition.
2. Douglas E. Comer, "Internetworking with TCP/IP Principles, Protocol and Architecture Volume 1" , 6th Edition
3. Peterson and Davis, "Computer Networks: A Systems Approach", Pearson, 5th edition
4. Fall Kevin and W. Richard Stevens , "TCP/IP Illustrated: The Protocols" Volume 1.
5. William Stallings, "Data and Computer Communication", Tenth Edition.

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Quantum and Spintronics Devices	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semiconductor Devices(DSC 3, Sem I), Engineering Mathematics (DSC 7, Sem III)

Learning Objectives

The objective of the course is to make the students understand the inadequacies of Classical Physics and know the basic postulates of Quantum Mechanics. Spintronics, a portmanteau meaning "spin transport electronics", where both charge and spin degrees of freedom of electrons are employed simultaneously to produce a device with new functionality, is a fascinating and promising field of research. It has the potential to revolutionize the field of electronics. Two physical bases of Spintronics, i.e., GMR and TMR have already been commercialized in read heads of the hard disk drive. It is extremely important and necessary to have a clear concept of spintronics so that students get exposure to such modern-day cutting-edge technology. Students will also learn general concepts about Spin-based quantum computing which is a leading technology for the realization of scalable quantum computers and other sectors too.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the limitation of classical physics and basic concepts of quantum Mechanics
- Understanding the concept of spintronics and spin-orbit
- Comprehend the spin relaxation and transport
- Design the spintronics devices using the laws
- Know the basic principles of various spintronic devices (sensors, memories, etc.)

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

UNIT – I (11 Hours)

Introduction to Quantum Mechanics: Inadequacies of Classical physics, Wave-particle duality, de Broglie waves, Schrödinger equation, expectation values, Uncertainty principle.

Basics of Quantum Mechanics: Solutions of the one-dimensional Schrödinger equation for a free particle, particle in a box, particle in a finite well. Reflection and transmission by a potential step and by a rectangular barrier. Basic understating of the Linear algebra of quantum computing.

UNIT – II (12 Hours)

History & Background of spintronics : GMR, Datta-Das, Spin relaxation, Spin injection, Spin detection

Electron Spin in Solids: Quantum Mechanics of spins, Pauli equation, Spin-Orbit coupling, Zeeman splitting, Current density, Magnetization, Bloch states with SO coupling, Electronic structure of GaAs, Dresselhaus and Rashba spin splitting, Optical orientation and spin pumping, Stern-Gerlach experiments with electron spins, Detection of free electron spin

UNIT – III (11 Hours)

Transport in magnetic materials and Spin injection: Materials for spin electronics, Nanostructures for spin electronics, Spin-polarized transport, Electrochemical potential, Spin accumulation, Spin diffusion, FN junction, Rashba formalism of linear spin injection, Equivalent circuit model, Silsbee-Johnson spin-charge coupling

UNIT – IV (11 Hours)

Spintronic Devices: Datta-Das spin-FET, P-N junctions, Magnetic bipolar diode, Magnetic bipolar transistor, Magnetic tunneling devices, MRAM, New memory technologies

Practical component (if any) – Quantum and Spintronics Devices

Hardware and Simulation-Based Lab Experiments

(Scilab/MATLAB/SPICE/Verilog A)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform lab experiment on splitting of atomic energy levels under magnetic field by Zeeman Effect
- Perform simulations to under spin phenomenon using transport and magnetic elemental modules using Scilab/MATLAB/SPICE/Verilog A

- Extending use of elemental modules to build Spin Circuit Models for complex structures

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Study of Zeeman Effect

Simulation using Transport and Magnetic Elemental Modules to understand Spin Phenomenon and build Spin Circuit Models using Scilab/MATLAB/SPICE/Verilog A (https://nanohub.org/groups/spintronics) for the following

2. Non Magnet
3. Ferromagnet
4. Magnetic Tunnel Junction
5. Rashba Spin Orbital
6. Giant Spin Hall Effect
7. Spin Pumping
8. Pure Spin Conductor
9. Magnetic Coupling

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

Essential/recommended readings

1. Beiser, Concepts of Modern Physics, McGraw-Hill Book Company (1987)
2. Sadamichi Maekawa, —Concepts in Spin Electronics, Oxford University Press (2006).
3. Bandyopadhyay S, Cahay M. Introduction to Spintronics. CRC press; 2015.

Suggestive readings

1. Isaac Chuang and Michael Nielsen, Quantum Computation and Quantum Information, Cambridge University Press, 2000.
2. Supriyo Bandyopadhyay and Marc Cahay, Introduction to Spintronics, CRC press, 2008

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

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DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Telecommunication Switching Systems and Networks	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Principles of Communication System(DSC 12, Sem IV)

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce and develop a conceptual understanding of telecommunication networks.
- To develop an understanding of basic traffic engineering and get familiar with the basics of modern telephone networks and data networks.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basics of various Switching Systems.
- Learn in detail about Time Division Switching.
- Understand the basics of Traffic Engineering.
- Learn the fundamentals of Data Networks.
- Understand the functionality of Telephone Networks and gain familiarity with ISDN.

SYLLABUS OF ELDSE-3C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Evolution of Telecommunications, Simple Telephone Communication, Manual Switching System, Major Telecommunication Networks, Strowger Switching System, Crossbar Switching.
Electronic Space Division Switching: Stored Program Control, Centralized SPC, Distributed SPC, Enhanced Services, Multi-stage Switches.

UNIT – II (12 Hours)
Time Division Switching: Time Multiplexed Space Switching, Time Multiplexed Time Switching, Combination Switching, Three-stage Combination Switching, *n*-stage Combination Switching.
Traffic Engineering: Network Traffic Load and Parameters, Grade of Service and Blocking Probability, Modelling Switching Systems, Incoming Traffic and Service Time Characterization, Introduction to Blocking Models, Loss Estimates and Delay Systems.

UNIT – III (11 Hours)
Data Networks: Block diagram, features and working of EPABX systems. Data Transmission in PSTNs, Data Rates in PSTNs, Modems, Switching Techniques for Data Transmission, Circuit Switching, Store and Forward Switching. Data Communication Architecture, ISO-OSI Reference Model, Link to Link layers, Physical Layer, Data Link Layer, Network Layer, End to End Layers, Transport Layer, Session Layer, Presentation Layer, Satellite Based Data Networks, LAN, Metropolitan Area Network, Fibre Optic Networks, and Data Network Standards.

UNIT – IV (11 Hours)
Telephone Networks and ISDN: Subscriber Loop Systems, Switching Hierarchy and Routing, Transmission Plan, Transmission Systems, Numbering Plan, Charging Plan, Signalling Techniques, Inchannel Signalling, Common Channel Signalling, Cellular Mobile Telephony.
Integrated Services Digital Networks (ISDN): ISDN services, Network and Protocol Architecture, Transmission Channels.

Practical component (if any) – Telecommunication Switching Systems and Networks
(MATLAB/SCILAB /Any other softwares)

Learning outcomes

The Learning Outcomes of this course are as follows:

- To learn about the various switching networks.
- To learn about traffic in the context of Telecommunication Network.
- To design and study a Local Area Network.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Simulation of Basic Switching Systems.

2. Simulation of TDMA.
3. Simulation of basic traffic parameters.
4. Simulation of PCM.
5. To study and perform TDM-PCM.
6. Study of EPABX System and its features
7. Study of LAN Trainer Kit.
8. Study of Optical Fiber Communication System.

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

Essential/recommended readings

1. Thiagarajan Viswanathan, Manav Bhatnagar, 'Telecommunication Switching Systems and Networks', Prentice Hall of India Learning Pvt. Ltd., 2015
2. J. E Flood, 'Telecommunications Switching, Traffic and Networks', Pearson Education, 2006
3. John C Bellamy, Digital Telephony, John Wiley International Student Edition, 3rd Edition, 2000
4. Tomasi, Introduction to Data Communication and Networking, Pearson Education, 1st Edition, 2007

Suggestive readings

1. Behrouz A. Forouzan, Data Communications and Networking, TMH, 2nd Edition, 2002

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

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- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

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

GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of 8085 Microprocessor	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Working of different logic gates

Learning Objectives

The Learning Objectives of this course are as follows:

- Various kinds of number systems and their basics.
- Fundamental understanding of the operations of microprocessors
- Assembly language programming
- Interfacing microprocessor with the real world.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Convert various number systems and operations thereof.
- Draw block diagrams after familiarization with internal architecture of 8085 microprocessor, its instruction set and basic programming.
- Write assembly language programs for 8085 microprocessor.
- Acquire skills in memory and peripheral interfacings to solve real world problems..

SYLLABUS OF ELGE-5A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Number systems: Binary, Hexadecimal - Conversion from Binary to Decimal and vice-versa, Binary to Hexadecimal and vice-versa, Decimal to Hexadecimal and vice versa, Addition and Subtraction of Binary Numbers and Hexadecimal Numbers. Subtraction using 2's Complement, Signed Number Arithmetic.

Introduction to Microprocessors: Introduction to Microprocessors, Microcontrollers and Microcomputers, Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors, Computer languages, Tri-state Logic, Address bus, Data bus and Control bus.

UNIT – II (12 Hours)

Microprocessor 8085: Features, Architecture, Pin Diagram, Block Diagram, Internal Registers, Microprocessor Operations – Microprocessor Initiated Operations, Internal Data and Peripheral or Externally Initiated Operations. Demultiplexing of Multiplexed Address and Data bus, Generation of Control Signals.

Interfacing of Memory Chips: Basic concepts in Memory Interfacing Structures, Address Allocation Technique, Address Decoding Techniques, Memory Map. Interfacing of I/O Devices with 8085, LEDs and Toggle-switches as examples, Memory-Mapped I/O and Peripheral-mapped I/O.

UNIT – III (11 Hours)

8085 Instructions: Instruction Set, Instruction Classification, Addressing Modes.

Data Transfer Instructions, Arithmetic Instructions, Increment & Decrement Instructions, Logical instructions, Branch instructions and Machine Control Instructions. Concept of Timing Diagram, Instruction cycle, Machine cycle and T- state. Assembly Language Programming Examples.

UNIT – IV (11 Hours)

Stack Operations: Stack, Subroutine, Call and Return operations, Advanced Subroutine Concepts.

Delay Loops: Looping, Counting and Indexing using Data Transfer, use of Counters. Time Delay Routines, Debugging Counter and Time Delay Programs.

Interrupt Structure of 8085 Microprocessor: Concept of Interrupt Mechanism, Hardware and Software Interrupt of 8085, Interrupts and Vector Locations, RST Instructions, Interrupt Related Instructions, SIM and RIM.

Introduction to Peripheral Programmble Interfacing Devices

Practical component (if any) – Fundamentals of 8085 Microprocessor
(Assembly Language Programming)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Write simple programs to understand the instruction set of 8085 microprocessor.
- Interface various I/O devices with microprocessor.
- Prepare the technical report on the experiments carried out.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to transfer a block of data.
2. Program for multibyte addition.
3. Program for multibyte subtraction.
4. Program to multiply two 8-bit numbers.
5. Program to divide two 8-bit numbers.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find the square root of an integer.
9. Program to sort numbers in ascending/descending order.

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

Essential/recommended readings

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Microprocessor 8085 and Its Interfacing, Sunil Mathur, PHI Learning Pvt. Ltd.

Suggestive readings

1. Fundamentals of Microprocessor & Microcomputer: B. Ram, Dhanpat Rai Publications.
2. Microcomputers and Microprocessors by John E Uffenbeck

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

GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Artificial Intelligence and Machine Learning	4	3	-	1	Class XII passed with Maths/Applied Maths	Python Programming fundamentals

Learning Objectives

Artificial Intelligence (AI) has emerged as one of the most rapidly growing technology sectors in today's time. This fascinating technology area which deals with designing 'machines which can think' is finding widespread application in almost every industrial and domestic sector. Rapid advancement in the field of AI has also led to complete revolution in the other technology areas including Robotics, embedded systems and Internet of Things.

This course will give an opportunity to gain knowledge in some of the fundamental aspects of AI. The main objective of this well-structured classroom program is to cover all the main topics related to designing machines which can replicate human intelligence and its applications in industry, defence, healthcare, agriculture, and other areas. This course will give the students advanced and professional graduate-level foundation in Artificial Intelligence.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Build intelligent agents for search and games
- Solve AI problems through programming with Python
- Learning optimization and inference algorithms for model learning
- Design and develop programs for an agent to learn and act in a structured environment

SYLLABUS OF ELGE-5B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Concept of AI, history, current status, scope, Modeling Techniques: Turing Test Approach, Cognitive Modeling Approach, Rational Agent Approach and Laws of Thought Approach, AI System Architecture: Concept of Agent & Environment, Types of Agents: Reactive Agent, Model based Reflex Agent, Omniscient Agent, Goal

Based Agent, Utility based Agent and Learning Agent, Types of Environment, PEAS representation of Intelligent Agents.

UNIT – II (12 Hours)

Problem Solving Agents: AI Problem Formulation, State space representation, Problem Solving Search Algorithms: Uninformed Search Algorithms: Breadth first search, Depth First Search, Depth Limited Search, Uniform Cost Search and Bidirectional Search, Heuristic Search Algorithms: concept of Heuristic Function, Greedy Best First Search and A* search algorithm.
Simple AI problems (such as Water Jug Problem, Maze Problem, 8-Tile Puzzle problem, Traveling Salesman Problem).

UNIT – III (11 Hours)

Game Search Algorithms: Minimax Search Algorithm and Alpha-Beta Pruning.
Probabilistic Reasoning Model: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability, Markov Model and Hidden Markov model.

UNIT – IV (11 Hours)

Introduction to Machine Learning: Overview of types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Passive and Active Reinforcement Learning
Markov Decision Process Model: MDP formulation, utility theory, utility functions, value iteration, policy iteration and Q- Learning. Elements of MDP Model, concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world

Practical component (if any) – Artificial Intelligence and Machine Learning
(Algorithms to be implemented in Python programming language)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement AI algorithms to solve single player puzzles (problems)
- Implement Adversarial (Game search) to design an intelligent game playing system
- Apply Bayesian statistics to apply probabilistic reasoning models
- Analyze the given data sets using basic machine learning algorithms

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Program to solve the given search tree using Breadth First Search
2. Program to solve the given search tree using Depth First Search
3. Program to solve the given search tree using Depth Limited Search
4. Program to solve the given search tree using Uniform Cost Search
5. Program to solve the given search tree using Greedy Best First Search

6. Program to solve the given search tree using A* Search
7. Program to solve the given game search tree using Minimax Search
8. Program for construction and inference of a Bayesian network
9. Write a Program to perform Regression on given data sets

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

Essential/recommended readings

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

Suggestive readings

1. David Poole and Alan Mackworth, —Artificial Intelligence: Foundations for Computational Agents, Cambridge University Press 2010
2. Saroj Kaushik, —Artificial Intelligence, Cengage Learning India, 2011

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
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SEMESTER-VI

UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

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

Add the following:

Syllabi of Semester-IV, V and VI of the following departments under Faculty of Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

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- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
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SEMESTER-VI
DEPARTMENT OF ELECTRONIC SCIENCE
Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 16: Digital Signal Processing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Digital Signal Processing	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Signals and Systems (DSC 9, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:
To introduce the techniques of modern digital processing that are fundamental to a wide variety of application areas. Special emphasis is placed on the basic concepts related to discrete-time signals and systems, the analysis of signals in time and frequency using Fourier and Z transform. Introduction to techniques involved in the architecture and design of digital filters.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Grasp fundamentals of discrete time signals, linear time-invariant systems, Z-transform and Fourier transform
- Analyze linear time-invariant systems using Fourier and Z transform

- Understand the Design techniques of Digital FIR and IIR filters using direct methods and methods involving conversion of the analog filter into the digital filter by various transformations.
- Use DFT to perform frequency analysis of signals and application of FFT algorithms.

SYLLABUS OF ELDSC-16 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)

Discrete Time Sequences and Systems: Introduction to Discrete Time sequences, Properties of DT systems.

Fourier Transform: Fourier Transform, Properties of Fourier Transform, Inverse Fourier Transform, Transfer Function of LSI systems.

UNIT – II (12 Hours)

Z-Transform: Definition, Unilateral Z- transform, Region of Convergence and its properties, Properties of Z-Transform, Initial and final value theorem.

Inverse Z Transform: Long division, Partial fraction, and Residual methods. Parseval's Theorem and applications.

System Function: Linear constant coefficient difference equation, Representation and analysis of Discrete Time Systems, Stability, Causality, Realisation of Digital Linear Systems: Block diagram, signal flow graph, structure for IIR and FIR systems

UNIT – III (12 Hours)

Discrete Fourier Transform: DFT assumptions and Inverse DFT, magnitude and phase representation Matrix relations, relationship with Fourier Transform, Linear and circular convolution, properties of DFT, Computation of DFT. FFT Algorithms-Decimation in time FFT. Decimation in frequency FFT, FFT using radix 2 FFT — Butterfly structure, Concept of Gibb's phenomenon and word length effects.

UNIT – IV (11 Hours)

Digital Filters: Comparison of Analog and Digital Filters, Types of Digital Filters: FIR and Hanning, Hamming, Blackman, Design of IIR Filters by Approximation of Derivates, Impulse Invariant Method, Bilinear Transformation, Butterworth Filter.

Practical component (if any) – Digital Signal Processing
(Scilab/MATLAB/Python other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Simulate, synthesize and process signals using a software tool.

- Apply transform methods for representing signals and systems in the time and frequency domain.
- Simulation and design of FIR and IIR Filters

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to generate discrete time Unit Sample, Unit Step, Unit ramp and Sinusoidal sequences.
2. Write a program to find the Fourier Transform of a sequence.
3. Write a program to find the pole-zero plot of a function.
4. Write a program to find a function's Z transform and inverse Z transform.
5. Write a program to find the circular convolution of two sequences.
6. Write a program to find the DFT of a sequence using the direct method.
7. Write a program to find the DFT of a sequence using FFT.
8. Magnitude Response of Low Pass Filter and High Pass Filter.
9. Design FIR Filter using Window Function.
10. Convert Analog Filter to Digital IIR Filter

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

Essential/recommended readings

1. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1999.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 2007.

Suggestive readings

1. S. Salivahanan, Digital Signal Processing, McGraw Hill, 2015.
2. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015.
3. Monson Hayes, Digital Signal Processing: Second Edition, Schaum's Outline Series

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

DISCIPLINE SPECIFIC CORE COURSE – 17: Photonics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Photonics	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Electro-magnetics (DSC 14, Sem V)

Learning Objectives

The Learning Objectives of this course are as follows:

- This course introduces the student to the fundamental understanding of light as an electromagnetic wave and various phenomenon like interference, diffraction and polarization and their applications.
- Interaction between a photon and electron and its relevance to laser and various other optoelectronic devices.
- Understand the propagation of wave in planar optical waveguides and optical fibers.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the optics and simple optical systems.
- Understand the concept of light as a wave and its propagation in optical fibres, and relevance of this to optical effects such as interference , diffraction, polarization and hence to lasers, holography and optical waveguides.
- Use mathematical methods to predict optical effects with e.g. light-matter interaction, wave propagation in guided media, dispersion, wave optics

SYLLABUS OF ELDSC-17 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Light as an Electromagnetic Wave: Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law.
Interference :Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings.
Diffraction: Fraunhoffer Diffraction by a single slit, double slit, Diffraction grating: Resolving power and Dispersive power

UNIT – II (11 Hours)
Holography: Basic Principle , Construction and reconstruction of hologram.
Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Half wave and quarter wave plates. Electro optic Effect, Faraday Rotation
Liquid Crystal Displays: Types, Working Principle.

UNIT – III (11 Hours)
Light Emitting Diodes: Construction, materials and operation.
Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, Laser cavity , Examples of common lasers. The semiconductor injection laser diode.
Photodetectors: Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

UNIT – IV (11 Hours)
Guided Waves and the Optical Fibre: Maxwell's Equations, TE modes in symmetric step index planar slab waveguides, effective index, field distributions, Step index optical fibre, total internal reflection, single mode and multimode fibres, attenuation and dispersion in optical fibres.

Practical component (if any) – Photonics
(Hardware Lab augmented with virtual lab)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on the phenomenon of light/photons.
- Measure the parameters such as wavelength, resolving power, numerical aperture etc. using the appropriate photonic/optical technique.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To determine Brewster's angle.
2. To determine wavelength of sodium light using Newton's Rings.
3. To determine the resolving power and Dispersive power of Diffraction Grating.
4. Diffraction experiments using a laser.

5. Viewing of different types of holograms.
6. To verify the law of Malus for plane polarized light.
7. Study of Faraday Rotation.
8. Study of Electro-optic Effect.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

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

In addition to the above hardware lab , teaching learning process can be further augmented using following/any other ONLINE virtual labs:

- Amrita Vishwa Vidyapeetham Virtual Lab https://vlab.amrita.edu/
- Virtual Labs ofcvlab.vesit.ves.ac.in

Essential/recommended readings

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. Ghatak A.K. and Thyagarajan K., —Introduction to fiber optics, Cambridge Univ. Press. (1998)

Suggestive readings

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)

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

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DISCIPLINE SPECIFIC CORE COURSE – 18: Semiconductor Device Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Semiconductor Device Technology	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semi-conductor Devices (DSC 3, Sem I)

Learning Objectives

The Learning Objectives of this course are as follows:

- The course deals with properties of materials required for Semiconductor Devices
- It deals with various processing steps
- It gives an account of how the Semiconductor Devices are fabricated (with details of all processes involved)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Summarize the developments in the field of microelectronics technologies
- Describe the crystal growth, diffusion, oxidation, lithography, etching and various film deposition processes.
- Explain the process sequence for PN junction, BJT, CMOS and BiCMOS fabrication

SYLLABUS OF ELDSC-18 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Semiconductor materials: Single crystal, polycrystalline and amorphous forms. Properties of Silicon and Gallium Arsenide. Materials used for doping Silicon and Gallium Arsenide

Crystal growth techniques: Starting material (SiO_2), MGS, EGS, Growth of bulk Silicon single crystals using Czochralski (CZ) technique, Doping while crystal growth (Distribution of dopants, Effective Segregation Coefficient), Float Zone (FZ) technique, GaAs bulk single crystal growth by LEC technique, Bridgman-Stockbarger technique.
Wafer Cleaning Technology : Basic Concepts, Wet cleaning, Dry cleaning

UNIT – II (12 Hours)
Epitaxy Deposition: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Growth of GaAs films by MOCVD.
Oxidation: Importance of Silicon Dioxide in Silicon, Thermal Oxidation Process, Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities on oxidation rates, Impurity redistribution during Oxidation, Oxide Quality, Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow

UNIT – III (11 Hours)
Diffusion: Thermal Diffusion, Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation, and its comparison with Thermal Diffusion.
Lithography: Clean room, Optical Lithography, Electron beam lithography, Photoresist, Photo masks, Wet Chemical Etching, Common etchants

UNIT – IV (11 Hours)
Metallization: Filament evaporation, e-beam evaporation, sputtering techniques used for metals (Aluminium, Gold, Copper etc..) deposition on Silicon and GaAs
Process Integration (IC): Isolation techniques. Fabrication of Monolithic Resistor, Inductor, Capacitor. PN junction, BJT, NMOS, PMOS, CMOS structures.
Concept of Bipolar Technology and MOSFET Technology for Devices

Practical component (if any) – Semiconductor Device Technology
(Scilab/MATLAB/other Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Operate the advanced computer simulations tools as well as visit research laboratories for better understanding of semiconductor fabrications processes.
- Perform the simulation of semiconductor crystal growth and device fabrication processes like oxidation and diffusion.
- Perform experiments to calculate the electronic parameters like resistivity, mobility, carrier concentration and band gap etc in semiconductors.
- Operate the deposition system for fabrications of thin films

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To measure the resistivity of semiconductor crystal with temperature by four – probe method.

2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. CZ technique Simulation
4. Float zone technique Simulation
5. Oxidation process Simulation
6. Diffusion Process Simulation
7. To design a pattern using photolithographic process and its simulation
8. Process integration simulation
9. Determination of Optical Bandgap through transmission spectra.
10. Visit to Research Lab/institutions to see the live demonstrations of the processes and preparation of a report.

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

Essential/recommended readings

1. Gary S.May and S.M.Sze , Fundamentals of Semiconductor Fabrication, John Wiley& Sons(2004)

Suggestive readings

3. Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press (1986).

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medical Electronics & Instrumentation	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Basic Instrument-ation & Measure-ment Techniques (DSC 4, Sem II), Micro-processor (DSC 11, Sem IV)

Learning Objectives

- This course introduces the student to the fundamental understanding of various types of Biomedical Signals and their physiological aspects.
- The students analyse the various types of Biomedical instruments and their working and practical implementation.
- Learn about Modern Imaging systems like CT and MRI techniques and various other cardiac instruments.
- Learn about Instrumentation for clinical lab: blood cell counter, oximeter, blood gas and blood ph analyser.
- Learn about the emerging fields like EEG, ECG, EMG etc.
- To learn about patient safety and precaution for instruments and electrodes.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic knowledge of physiology and generation of bio electric signals (ECG, EMG, EEG etc.) in humans.
- Describe cardio vascular monitoring systems , Bed side monitor, ECG-Telemetry.
- Describe the basic knowledge on respiratory and pulmonary measurements.
- Describe modern methods of imaging techniques like CT, X-Ray, NMR and MRI.

- Describe conditions for patient safety
- Describe instrumentation for clinical Lab like Blood cell counters, oximeter, blood gas and blood pH analyser..

SYLLABUS OF ELDSE-4A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)

Biomedical signals and transducers

Physiological systems of human body: Introduction, Origin of biomedical signals, Use of microprocessors, Microcontrollers and computers in medical instruments, **Transducers:** Ultrasound transducer, Radiation and chemical thermometry, optical fibre sensor, biosensors, optical glucose sensor, Electrodes & its types: for ECG, EMG & EEG

.

UNIT – II (12 Hours)

Cardiovascular monitoring systems: Patient cardiovascular Monitoring systems Cardiovascular System, blood pressure measurement, cardiac rate and output measurement, Cardiac monitor- Waveforms, ECG amplifier, phonocardiography, Ballisto cardiography, Eco-Cardiograph, Bed side monitor –block diagram- measuring parameters-cardiac tachometer-Alarms-Lead fault indicator-central monitoring. Telemetry – modulation systems – choice of carrier frequency – single channel telemetry systems, Cardiac pacemakers: Introduction, Cardiac defibrillators

UNIT – III (12Hours)

Imaging Systems

X-rays: Properties and production, Block diagram of x-ray machine, Diagnostic radiology, Dental X-ray, Basic principle and components of X-Ray Computed Tomography (CT)

MRI: Principle and NMR imaging components

Introduction to Ultrasonic imaging system.

UNIT – IV (11 Hours)

Patient's safety: Precaution, safety codes for electro medical equipment, Electric safety analyser, Testing of biomedical equipment.

Instrumentation for Clinical Laboratory: Blood cell counters, Oximeter, Blood flow meter, Blood gas analysers, Blood pH analyser.

Measurement in Respiratory system: Physiology of respiratory system, Measurement of breathing mechanics Spiro meter, Respiratory therapy equipment Inhalators ventilators & Respirators, Humidifiers, Nebulizers Aspirators.

Practical component (if any) – Medical Electronics & Instrumentation

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with functioning of biomedical instrumentation
- Perform experiments on the biomedical instruments, collect & analyze the data
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To simulate Bio potential Amplifier.
2. Study on ECG simulator.
3. Study on EEG simulator.
4. Study on EMG simulator.
5. Study of various leads and electrode position for ECG and EEG.
6. Study of pulse rate monitor (Pulse oximetry).
7. To simulate defibrillator.
8. Measurement of heart sound using electronic stethoscope.
9. Simulation of blood cell counter.
10. Study of NMR using virtual lab.
11. Visit to a Diagnostic lab/Pathology lab/Hospital to understand working of various instruments and preparation of a report.

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

Essential/recommended readings

1. Khandpur R. S. - Handbook of Biomedical Instrumentation, TMH.
2. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, Pearson.
3. Shakti Chatterjee, —Textbook of Biomedical Instrumentation System‖, Cengage Learning.
4. Prof. S.K.VenkataRam-Bio-Medical Electronics and Instrumentation, Galgotia Publications.

Suggestive readings

1. Bertil Jacobson & John G. Webster - Medicine and Clinical Engineering, PHI.

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

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DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advance Computer System Architecture	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Microprocessor (DSC 11, Sem IV) or equivalent to Computer System Architecture, Operating system(DSE 2B, Sem IV)

Learning Objectives

- To give the students an elaborate idea about the different memory systems and buses.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputer.
- To study about data flow computer architectures
- To make students know about the Parallelism concepts

Learning outcomes

The Learning Outcomes of this course are as follows:

- Demonstrate concepts of parallelism in hardware/software.
- Discuss memory organization and mapping techniques.
- Describe architectural features of advanced processors.
- Interpret performance of different pipelined processors.
- Explain data flow in arithmetic algorithms
- Development of software to solve computationally intensive problems.

SYLLABUS OF ELDSE-4B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (10 Hours)

Computer Architecture & Organization: Instruction codes, Computer instructions, Basics of Input/Output & Interrupts, Complete computer description & design of basic

computer. Control Unit: Hardwired vs. Micro programmed control unit. Flynn's classification.

UNIT – II (11 Hours)

Memory Hierarchy: Hierarchical memory organization, Types of Cache Memory, Memory Interleaving, Replacement algorithms + write policy, Concept of Virtual Memory and Virtual Machine.

Parallel Processing: Definition, Theory of Parallelism. Parallel Computer Models, Implicit Parallelism vs. explicit parallelism, Levels of parallelism. Software Parallelism, Hardware Parallelism.

UNIT – III (12 Hours)

Pipelining: Basic Concepts of pipelining, Linear pipeline processor, Asynchronous and Synchronous models, speed up, Efficiency, Throughput, Instruction pipeline. Pipeline hazards and their Resolution Mechanisms like data forwarding, Delayed Branch, Branch Prediction, Dynamic Branch Prediction, Concept of Vector processing.

UNIT – IV (12 Hours)

Instruction Level Parallelism (ILP) Instruction-level Parallelism: Introduction, Challenges, Limitations, Basic Compiler Techniques for ILP, Branch Prediction, Out of order execution, Dynamic Scheduling, Limitations of ILP. Introduction to Thread Level Parallelism (TLP) and Data Level Parallelism (DLP). Introduction to Virtualisation Architecture, Virtualisation as a concept of Cloud Computing.

Practical component (if any) – Advance Computer System Architecture
(FPGA/Virtual Lab/Tejas Architecture Simulator)

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. To design a 4-bit common bus using 4:1 mux to transfer data from register to bus.
2. To design a 2-bit combinational shifter circuit which implements the logical shift, circular shift, arithmetic shift for both direction.
3. To design 2 bit arithmetic circuit which performs the following arithmetic operations add, add with carry, subtract, subtract with borrow, increment and decrement.
4. Design of Arithmetic Logical Unit ALU
5. Design of Memory: Design of a RAM cell
6. Design of Memory: Design of a 4X4 RAM
7. Design of Direct Mapped Cache
8. Design of Associative Cache
9. Using Architectural Simulator Tejas as
    a. Emulator
    b. Transfer Engine

c. Translational Modules
d. Micro architectural Simulation

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight, experiment no. 9 is compulsory.

Essential/recommended readings

1. "Computer Architecture: A Quantitative Approach", by John L. Hennessy and David A. Patterson, Morgan Kaufmann, 5th edition, 2011, ISBN: 9780123838728.
2. "Computer System Architecture" by M. Morris Mano (Pearson Publication)

Suggestive readings

1. "Computer Organization and Architecture", William Stallings, Prentice Hall, 10th edition, 2015, ISBN-10: 013293633X, ISBN-13: 978-0132936330
2. "Advanced computer architecture", Kai Hwang, TMH. 2000

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

This document is prepared from the following University Notifications

- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem1.pdf
- https://www.du.ac.in/uploads/new-web/notifications-2021/28032023_nep-Faculty%20of%20Interdisciplinary%20&%20Applied%20Sciences.pdf
- https://www.du.ac.in/uploads/new-web/15092023_Indis_sem3.pdf
- https://www.du.ac.in/uploads/new-web/18092023_Inter_4.pdf

DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Transmission Lines, Antenna and Wave Propagation	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Electromagnetics (DSC 14, Sem V)

Learning Objectives

The Learning Objectives of this course are as follows:

- Fundamentals of propagation of electromagnetic waves.
- Basics of transmission lines along with its parameters.
- Wave propagation in different modes of the waveguides.
- Antenna parameters and its radiation mechanism.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand reflection and transmission of uniform plane wave.
- Explain the functioning of transmission line and its performance parameters.
- Understand wave propagation in waveguides and different modes of propagation.
- Explain the radiation mechanism and characteristics of an antenna.

SYLLABUS OF ELDSE-4C **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Electromagnetic Wave Propagation: Plane Wave reflection at Oblique Incidence:- Laws of Reflection, Snell's Law of Refraction, Parallel and Perpendicular polarisations, Fresnel's Equations and Brewster Angle, Wave propagation in dispersive media, Concept of phase velocity and group velocity

UNIT – II (11 Hours)

Transmission Lines: Typical Transmission lines- Coaxial, Two-Wire, Microstrip and Coplanar, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines:- lossy, lossless and Distortionless lines, Input Impedance, Standing Wave Ratio, Power, Shorted Line, Open-Circuited Line and Matched Line, Quarter wave transformer as transmission line application.

UNIT – III (11 Hours)

Waveguides: Introduction to Parallel plate waveguide, Rectangular waveguide, Transverse Electromagnetic (TEM), Transverse Magnetic (TM) and Transverse Electric (TE) modes, cutoff frequency and dominant mode, Intrinsic Impedance, Power transmission and attenuation:- conductor loss and dielectric loss and Rectangular cavity resonator and its resonant frequency.

UNIT – IV (12 Hours)

Antenna: Concept of retarded potentials, Radiation Mechanism, types of antennas, power radiated by Hertzian dipole and its radiation resistance, qualitative analysis of half-wave dipole and quarter-wave monopole antenna, Antenna characteristics, Radiation Pattern, Beamwidth, Bandwidth, Radiation Intensity, Directive Gain, Directivity, Power Gain, Radiation Efficiency, Input Impedance, Effective Area and the Friis Transmission Equation.

Practical component (if any) – Transmission Lines, Antenna and Wave Propagation
(MATLAB/SCILAB /Any other softwares)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the phasor and its graphical representation for electromagnetic fields.
- Learn reflection and transmission of plane electromagnetic wave.
- Represent graphically various parameters of transmission line.
- Plot field configuration for different modes of the waveguide.
- Understand the radiation pattern and other characteristics of an antenna.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a plane wave
3. Program to find the electric and magnetic fields of reflected and transmitted wave at the interface of different types of media
4. Program to find the characteristic impedance and the phase constant of a distortionless line
5. Program to find the power dissipated of the lossy transmission line
6. Program to find the total power transmitted through the lossless transmission line
7. Program to plot the field configuration for TE and TM modes in waveguide
8. Program to determine the operating range of frequency for TE10 mode of air filled rectangular waveguide
9. Program to determine Directivity, Bandwidth and Beamwidth of an antenna.
10. Program to plot the radiation pattern of a Hertzian dipole and calculate its radiation resistance.

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

Essential/recommended readings

1. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press (2001)
2. Karl E. Longren, Sava V. Savov, Randy J. Jost., Fundamentals of Electromagnetics with MATLAB, PHI
3. J. A. Edminister, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
4. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
5. G. S. N. Raju, Antennas and Propagation, Pearson Education (2001) Transmission Lines,

Suggestive readings

1. W. H. Hayt and J.A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
2. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)

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

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

GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Microcontroller Systems	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Basic C language program-ming

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand architecture of Microcontroller.
- Write assembly language / C programs for the microcontroller.
- Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory and I/O.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the concepts related to architecture of microcontrollers
- Demonstrate knowledge of the development tools for a microcontroller, and write assembly language code according to specifications
- Design systems for common applications like general I/O, counters, data acquisition etc.
- Interfacing the external devices to the controller according to the user requirements to create novel products and solutions for the real - time problems.

SYLLABUS OF ELGE-6A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to microcontroller: Introduction to Microcontroller based system, Difference between Microprocessor and Microcontroller, Classification of microcontrollers based on architecture and Instruction Set (Overview of Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers), Microcontroller Features - Brown out Detector, Watch Dog Timer.

UNIT – II (12 Hours)

Architectural Overview of AVR Microcontroller: Block diagram description of ATMEGA32, Pin Description of ATMEGA32, AVR status register, General Purpose Register File, X, Y & Z registers, Stack Pointer, System Clock and Clock Options in AVR, System Control and Reset, Sleep Modes, AVR ATmega32 Memories: Flash Program Memory, SRAM Data Memory, EEPROM Data Memory & I/O Memory.

UNIT – III (11 Hours)

Instruction set of AVR Microcontroller: Addressing modes, Instruction set of AVR microcontroller, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, Bit manipulation instructions, MCU Control Instructions, Simple programs in Assembly Language / C Language

UNIT – IV (11 Hours)

AVR on-chip peripherals: General purpose I/O Ports, AVR I/O Port Programming, Introduction to interrupts, External interrupts, 8 and 16-bit Timers, Timer programming.

Practical component (if any) – Microprocessor System
(Hardware and AVR Studio/ Other suitable IDE)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Be proficient in use of IDE's for assembly/ C programming for the microcontroller.
- Interface various I/O devices to provide solutions to real-world problems.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to transfer a block of data.

2. Program to find the sum/subtraction of two 8-bit numbers.
3. Program to find the sum of N 8-bit numbers.
4. Program to find multiplication/ Division of two 8-bit numbers.
5. Program to find smallest of N numbers
6. Program to find the square root of 8-bit number.
7. Program to sort the numbers in ascending/ descending order.
8. Flash LED at observable rate.
9. Interface Input Switches and output LEDs.
10. Interface 7 segment display.

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

Essential/recommended readings

1. Programming and Customizing the AVR Microcontroller, By Dhananjay Gadre, McGraw Hill Education

Suggestive readings

1. The AVR Microcontroller and Embedded Systems Using Assembly and C, By Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Pearson Education.
2. AVR ATmega32 data sheet- ATMEL Corporation

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

GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Arduino/ Rpi App Development	4	2	-	2	Class XII passed with Maths/Applied Maths	Basic C language programming

Learning Objectives

This course introduces the student to the fundamental understanding of Arduino/Rpi processors. After completion of this course students should be well versed in programming the microcontroller. They should be able to use various sensors and make microcontroller respond to the external environment.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concepts of Arduino Uno / Raspberry Pi and the programming environments.
- Understand digital and analog ports of a microcontroller and their usage.
- Understand the working of various sensors and their application in robotics.
- Design different circuits and display their outputs using LCD and other indicator

SYLLABUS OF ELGE-6B Total Hours- Theory: 30 Hours, Practicals: 60 Hours

UNIT – I (8 Hours)

Basic functionality of the Arduino/ Rpi board and its processor, Setting and configuring the board: Pin diagram of Arduino/Rpi development board, Integrated Development Environment (IDE), IDEs like AVR Studio, WIN AVR, ARM 11, Installing and configuring for Robot programming, In System Programmer (ISP), loading programs on Robot, Differentiating Arduino board from Rpi board.

UNIT – II (8 Hours)

Introduction of Embedded C Programming and programming concepts for Arduino/ LINUX for Rpi, Digital Ports: Data Read and Write, Interfacing LEDs, Buzzer, Switches, 7 segment displays, LED dot matrix, Traffic lights, Introduction to 2 x 16 Characters LCD, Basic LCD control, Displaying message on LCD.

UNIT – III (6 Hours)

Sensors: IR range sensor of different range, Analog IR proximity sensors, Ultrasound scanner, LDR, Gyroscope and Accelerometer, Magnetometer, GPS receiver.

UNIT – IV (8 Hours)

Communication with Arduino/ Raspberry Pi : Wired RS232 (serial) Communication, Wireless ZigBee Communication, USB Communication, Simplex infrared Communication (IR remote to robot), Reading and writing to SD card.

Practical component (if any) – Arduino/Rpi App Development
(Supporting IDE)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with the Arduino/Rpi microcontroller development boards.
- Understand interfacing of various display devices viz. 7-segment display, LED dot matrix, LCD.
- Understand various sensors, their applications and designing control experiments using

LIST OF PRACTICALS (Total Practical Hours- 60 Hours)

1. To blink an LED/interface a Buzzer using a digital pin of the processor.
2. To display binary count on LEDs using digital port of the processor.
3. To display decimal count on a 7-segment display.
4. To read data from a digital port of the processor and then display it on other digital port.
5. To print a message on LCD.
6. To display different patterns on LED dot matrix.
7. To read the voltage of a potentiometer using analog port of the processor and depict the variation on LEDs/LCD.
8. To interface IR proximity sensor to determine if some obstacle is nearby.
9. To interface Ultrasonic sensor to determine if some object is in the facing direction.
10. To interface LDR and display if its dark or bright on 7 segment/LCD.
11. To design a Traffic Light System
12. To design a Voice Control Home Automation
13. To design a PWM based variable system
14. To design a wireless appliance controlling system.

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

Essential/recommended readings

1. Michal Mc Roberts "Beginning Arduino" Second Edition, Technology in Action
2. Massimo Banzi, "Getting started with Arduino" 2nd Edition, Orelly 2011
3. Richard Blum, " Arduino Programming in 24 Hours", Pearson Education, 1st edition, 2015.

Suggestive readings

1. Simon Monk, "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions", O'Reilly Reprints; Second edition 2016

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