Department of Electronic Sciences

BSc. (Hons.) Electronic Sciences

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.**