Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus

For

B. Sc. (Data Science)

Choice Based Credit System (CBCS) Syllabus
Under National Education Policy (NEP)

To be implemented from Academic Year 2025-2026

Level:- 4.5 (First Year) Sem : I

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ (T/P) (2) or T(4)	24CsDscU1101	Problem Solving and Python Programming	2		2		20	30	50
	24CsDscU1102	Lab Course on Python Programming		2		4	20	30	50
Subject 2 T(2)+ (T/P) (2) or T(4)	24CsDscU1103	Descriptive Statistics	2		2		20	30	50
	24CsDscU1104	Lab Course on Descriptive Statistics		2		4	20	30	50
Subject 3 T(2)+ (T/P) (2) or T(4)	24CsDscU1105	Computational Mathematics	2		2		20	30	50
	24CsDscU1106	Lab Course on Computational Mathematics		2		4	20	30	50
IKS T(2)	24CpCopU1901	Generic IKS	2		2		20	30	50
GE/OE (T/P) (2)	24CsCopU1401	Computer Fundamentals	2		2		20	30	50
SEC (P) (2)	24CsDscU1601	Software Engineering		2		4	20	30	50
AEC T(2)	24CpCopU1701 / 24CpCopU1702	MIL-I (Hindi) / MIL-I (Marathi)	2		2		20	30	50
VEC T (2)	24CpCopU1801	Environmental Science	2		2		20	30	50
Total			14	08	14	16			550

Level:- 4.5(First Year) Data Science

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ T/P(2) or T(4)	24CsDscU2101	Advanced Python Programming	2		2		20	30	50
	24CsDscU2102	Lab Course on Advanced Python Programming		2		4	20	30	50
Subject 2 T(2)+ P(2)	24CsDscU1103	Discrete Probability and Probability Distributions	2		2		20	30	50
	24CsDscU1104	Lab Course on Discrete Probability and Probability Distributions		2		4	20	30	50
Subject 3 T(2)+ P(2)	24CsDscU1105	Graph Theory	2		2		20	30	50
	24CsDscU1106	Lab Course on Graph Theory		2		4	20	30	50
GE/OE (T/P) (2)	24CsCopU2401	Digital Marketing	2		2		20	30	50
SEC P(2)	24CsStaU2601	Lab course on Excel		2		4	20	30	50
AEC T(2)	24CpCopU2703	English Communication Skills I	2		2		20	30	50
VEC T(2)	24CpCopU2801	Democracy, Election and Governance	2		2		20	30	50

CC (2)	24CpCopU2001/ 24CpCopU2011 / 24CpCopU2021 / 24CpCopU2031 / 24CpCopU2041 / 24CpCopU2051 / 24CpCopU2061 / 24CpCopU2071	Physical Education /Cultural Activities /NSS /NCC /Fine Arts /Applied Arts /Visual Arts Performing Arts	2		2		20	30	50
Total			14	08	14	16			550

Level:- 5.0 (Second Year) Sem:III

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24CsDscU3101	Database Management System	2		2		20	30	50
	24CsDscU3102	Data Structure-I	2		2		20	30	50
	24CsDscU3103	Lab Course DBMS and DS-I		2		4	20	30	50
VSC P(2)	24CsDscU3501	Foundation of Data Science		2		4	20	30	50
IKS (T/P)(2)	24CsDscU3901	Vedic Maths and Computer Fundamentals	2		2		20	30	50
FP P(2)	24CsDscU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24Cs***U3301	Project Management I (Object Oriented Software Engineering)	2		2		20	30	50
	24CsDscU3302	Lab Course on Advanced Excel		2		4	20	30	50
GE/OE (T/P) (2)	24CsDscU3401	Cyber Security		2		4	20	30	50
AEC T(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CC T(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			12	10	12	20			550

Level: - 5.0 (Second Year) Sem: IV

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24CsDscU4101	Relational Database Management System	2		2		20	30	50
	24CsDscU4102	Data Structure-II	2		2		20	30	50
	24CsDscU4103	Lab on RDBMS and DS - II		2		4	20	30	50
VSC P(2)	24CsDscU4501	Data Analytics		2		4	20	30	50
CEP P(2)	24CsCopU4003	Community Engagement Project		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24CsDscU4301	Project Management - II (Software Project Management)	2		2		20	30	50
				2		4	20	30	50
GE/OE (T/P) (2)	24CsDscU4401	Web Designing		2		4	20	30	50
SEC T(2)	24CsDscU4601	Big Data Analytics	2		2		20	30	50
AEC T(2)	24CpCopU4701 / 24CpCopU4702	MIL-II (Hindi) / MIL-II (Marathi)	2		2		20	30	50
CC T(2)	24CpCopU4001	Health and Wellness	2		2		20	30	50
Total			12	10	12	20			550

Level:- 5.5 (Third Year) Sem:-V

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4 + 2+2 or 4 + 4) P(2+2 or 4)	24CsDscU5101	NoSQL databases	2		2		20	30	50
	24CsDscU5102	R Programming	2		2		20	30	50
	24CsDscU5103	Foundations of Artificial Intelligence	4		4		20	30	50
	24CsDscU5104	Lab Course on NOSQL		2		4	20	30	50
	24CsDscU5105	Lab Course on R Programming		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24CsDscU5201	Business Analytics	2		2		20	30	50
	24CsDscU5203	Lab Course on Business Analytics		2		4	20	30	50
	OR								
	24CsDscU5203	Social Media Analytics	2		2		20	30	50
	24CsDscU5204	Lab Course on Social Media Analytics		2		4	20	30	50
VSC P(2)	24CsDscU5501	Lab Course on MATLAB		2		4	20	30	50
FP (2)	24CsDscU5001	Field Project II		2		4	20	30	50
Minor (T/P) (2)	24Cs***U5302	Project Management-III (Software Testing)	2		2		20	30	50
Total			12	10	12	20			550

Level:- 5.5 (Third Year) Sem:-VI

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4+2+2 or 4+4) P(2+2 or 4)	24CsDscU6101	Data Visualization and Modelling	2		2		20	30	50
	24CsDscU6102	Artificial Intelligence in Data Science	2		2		20	30	50
	24CsDscU6103	Data Security and Privacy	2		4		40	60	100
	24CsDscU6104	Machine Learning	2						
	24CsDscU6105	Lab on Data Visualization and Modeling		2		4	20	30	50
	24CsDscU6106	Lab on Artificial Intelligence in Data Science and Machine Learning		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24CsDscU6201 (T+P)	HR Analytics &	2		2		20	30	50
		Lab Course HR Analytics		2		4	20	30	50
	OR								
	24CsDscU6204 (T+P)	Financial Analytics &	2		2		20	30	50
		Lab on Financial Analytics		2		4	20	30	50
VSC P(2)	24CsDscU6501	Project		2		4	20	30	50
OJT (2)	24CsDscU6004	On Job Training		4		8	40	60	100

Semester I

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Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune – 5

FY.B.Sc. (Data Science)
(2025 Course under NEP)

Course Code: 24CsDscU1101

Course Name: Problem Solving and Python Programming

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- **An understanding of programming in an Imperative Language (e.g., C/C++ etc.)**
- **Knowledge of basic algorithms and Data Structures (e.g., Sorting, Searching, Lists, Queue, Stacks)**
- **Knowledge of basic Discrete Mathematics (e.g., Sets, Relations, Functions)**

Course Objectives:

- **To introduce Python programming fundamentals and problem-solving skills.**
- **To cover essential Python concepts such as control structures, functions, and file handling.**
- **To introduce PostgreSQL database connectivity using Python.**
- **To implement real-world applications using Python and databases.**

Course Outcomes:

After successful completion of this course students will able to:

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Define and demonstrate the use of built-in data structures "lists" and "dictionary".	1
CO 2	Understand why Python is a useful scripting language for developers.	2
CO 3	Apply conditional statements, loops, and functions to solve basic problems.	3
CO 4	Analyze different data structures like lists, tuples, sets, and dictionaries to perform data operations.	4
CO 5	Evaluate the use of file handling and exception handling mechanisms in Python programs.	5
CO 6	Develop simple Python-based applications using appropriate programming constructs and data structures.	6

Course Contents:

Unit 1	Introduction to Python	05 lectures
	1.1 History and Features of Python 1.2 Installation and Setup (Python, IDEs) 1.3 Writing and Running Python Scripts 1.4 Variables, Data Types, and Type Casting 1.5 Operators (Arithmetic, Logical, Relational etc.)	
Unit 2	**Control Structures**	**05 lectures**
	2.1 Conditional Statements: if, if-else, if-elif-else 2.2 Looping Statements: for, while 2.3 Loop Control Statements: break, continue, pass 2.4 Iterators and Generators 2.5 List Comprehension	
Unit 3	**Data Structures**	**05 lectures**
	3.1 Lists: Creation, Slicing, and Methods 3.2 Tuples: Properties and Operations 3.3 Sets: Operations and Applications 3.4 Dictionaries: Key-Value Pairs and Methods 3.5 Nested Data Structures	
Unit 4	**Functions and Modules**	**05 lectures**
	4.1 Defining and Calling Functions 4.2 Function Arguments & Return Values 4.3 Scope of Variables (Local & Global) 4.4 Lambda Functions and Recursion 4.5 Importing and Creating Modules	
Unit 5	**File Handling and Exception Handling**	**05 lectures**
	5.1 File Handling Basics (Read, Write, Append) 5.2 File Modes 5.3 Exception Handling: try-except-finally 5.4 Debugging and Error Handling	
Unit 6	**Database Connectivity**	**05 lectures**
	6.1 Connecting Python with database 6.2 Executing SQL Queries	

Reference Books:

1. Python Programming using problem solving approach by Reema Thareja, Oxford University Press.2017,ISBN-10 : 0199480176; ISBN-13 : 978-0199480173

2. Introduction to Computation and Programming Using Python with application to understanding data by Guttag John V.PHI, ISBN-10 : 0262519631; ISBN-13 : 978-0262519632

3. Introduction to Computer Science using Python by Charles Dierbach, Wiley, ISBN: 9788126556014, 9788126556014

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune – 5

FY.B.Sc. (Data Science)
(2025 Course under NEP)

Course Code: 24CsDscU1102
Course Name: Lab Course on Python Programming

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Implement and debug basic Python programs.	3
CO 2	Apply conditional statements, loops, and control structures to solve practical problems.	3
CO 3	Use functions, recursion, and modules to develop modular code.	3
CO 4	Apply operations on lists, tuples, sets, and dictionaries to handle data.	3
CO 5	Demonstrate file handling and exception handling through practical tasks.	3
CO 6	Develop small Python applications integrating database connectivity.	6

Course Contents:

Sr.No	List of practical
1	**Basic Python Programming** A. Writing and Executing Simple Python Programs B. Implementing Operators and Type Casting C. Working with input() and print() Functions D. Simple Arithmetic Operations and Expression Evaluation E. Debugging Simple Python Programs
2	**Control Statements** A. Implementing if-else and Nested Conditions B. Using Loops (for and while) for Pattern Printing C. Writing Programs Using Loop Control Statements D. Generating Fibonacci Series, Factorial, and Prime Numbers E. Implementing List Comprehension

3	**Functions and Modules** A. Writing and Calling User-Defined Functions B. Implementing Different Types of Function Arguments C. Using Built-in Functions (len(), sum(), max(), min()) D. Recursion Programs (Factorial, Fibonacci) E. Importing and Using Built-in Modules (math, random)
4	**Data Structures** A. Working with Lists: Adding, Removing, Updating Elements B. Performing Operations on Tuples and Sets C. Using Dictionary Methods (get(), keys(), values(), items()) D. Implementing Nested Lists and Dictionaries E. Sorting and Searching Data in Python Collections
5	**File Handling and Exception Handling** A. Writing and Reading Text Files (.txt, .csv) B. Implementing File Operations (Open, Read, Write, Append) C. Working with Exception Handling (try-except) D. Handling Multiple Exceptions and Using finally E. Debugging Errors and Implementing assert Statements
6	**Database Connectivity** A. Creating a Database B. Connecting Python to database

Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune – 5

First Year of B.Sc. Data Science
Course under NEP 2025-26

Course Code: 24CsDscU1103
Course Name: Descriptive Statistics

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks Prerequisite**

Courses:

- Basic Mathematics.

Course Objectives:

- To study different types of data.
- To Study Statistical Population and sample.
- To compute different types of measures of central tendency and dispersion.
- To Study the concept of skweness, kurtosis.
- To study kind and extent of relationship between two variable.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Classify data sets according to types of variables and data.	2
CO 2	Compute appropriate measures of central tendency for given data sets.	3
CO 3	Compute measures of dispersion and analyze data variability.	3
CO 4	Calculate different types of moments for data sets.	3
CO 5	Interpret skewness and kurtosis for real-life data analysis.	4
CO 6	Determine the kind and extent of relationship between two variables.	4

Course Contents

Unit 1	**Population and Sample**	**03L**
	1.1 Types of characteristics: Qualitative: Measurement scale: Nominal scale, ordinal scale (Use of Likert scale). Quantitative: Discrete and continuous variables : Measurement scale (Using interval scale, ratio scale) 1.2 Types of data: (a) Primary data, Secondary data. (b) Cross-sectional data, Time series data, Directional data. 1.3 Notion of a statistical population and sample: Finite population, infinite population, homogeneous population and heterogeneous population.	
Unit 2	**Measures of Central Tendency**	**10L**
	2.1 Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. 2.2 Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean. 2.3 Mode and Median: Definition, merits and demerits. Empirical relation between mean, median and mode. 2.4 Partition values: Quartiles, Deciles and Percentiles. Geometric Mean (G.M.): Definition, merits and demerits. Harmonic Mean (H.M.): Definition, merits and demerits. Order relation between arithmetic mean, geometric mean, harmonic mean. 2.5 Weighted Mean: weighted A.M., G.M. and H.M. 2.6 Situations where one kind of average is preferable to other.	
Unit 3	**Measures of Dispersion**	**07L**
	3.1 Concept of dispersion, characteristics of good measure of dispersion. 3.2 Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits. 3.3 Mean absolute deviation: Definition, merits and demerits, minimality property (without proof) 3.4 Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups).Mean squared deviation: Definition, minimality property of mean squared deviation. 3.5 Measures of dispersion for comparison: Coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.).	
Unit 4	**Moments, Skewness and Kurtosis**	**06L**

	4.1 Moments: Raw moments (m'_r) for ungrouped and grouped data. Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale. Relations between central moments and raw moments upto 4^{th} order. 4.2 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution and its relation with central tendency. Bowley's coefficient of skewness: Bowley's coefficient of skewness, Karl Pearson's coefficient of skewness, Measures of skewness based on moments (β_1,γ_1).	

	4.3 Concepts of kurtosis, Types of kurtosis: Leptokurtic, Mesokurtic and Platykurtic, Measures of kurtosis based on moments (β_2,γ_2). 4.4 Properties of β_1 and β_2 (i) $\beta_2 \geq 1$ (ii) $\beta_2 \geq \beta_1+1$ (Statement of results related measures of skewness and kurtosis).	
Unit 5	**Correlation**	**04L**
	5.1 Measure of linear dependence between two variables: Covariance between two variables (m11) : Definition, computation, effect of change of origin and scale. Karl Pearson's coefficient of correlation (r) : Definition, Properties: (i) $-1 \leq r \leq 1$ (ii) Effect of change of origin and scale Computation for ungrouped data and grouped frequency distributed data with interpretation. 5.2 Spearman's rank correlation coefficient: Definition, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Derivations are not expected)	

References:

1. Agarwal B. L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, NewDelhi.
2. Das (2009). Statistical Methods, Tata Mcgraw Hill *Publishing.*
3. *Dixit P.G, Prayag V.R.,.Descriptive Statistics,Nirali prakashan., Pune*
4. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. 1, 6^{th} Revised Edition, The World Press Pvt. Ltd., Calcutta.
5. Gore.Anil, Pranjapesharayu ,Kulkarni Madhav. Statistics for everyone. SIPFAcadamy publisher,Nashik
6. Gupta, S. C. and Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics, 10^{th} Edition, Sultan Chand and Sons Publishers, New Delhi.
7. Krzanowski (2007). Statistical Principals and Techniques in Scientific and Social Research, Oxford University Press Inc., New York.
8. Mohanty (2016). Basic Statistics, Scientific Publisher
9. Mukhopadhyay P. (2015). Applied Statistics ,*Publisher*: Books & Allied (*P*) Ltd.
10. Purohit, S. G., Gore S. D.,Deshmukh S. R (2008). Statistics Using R, Narosa Publishing House, NewDelhi
11. Rastogi (2015). Biostatistics, 3rd Edition, Publisher Medtec
12. Robert S. Witte, John S. Witte (2017). Statistics, *Publisher*: Wiley

13. *Roussas*, George G. (2016). First course in mathematical *statistics*.2nd edition *Publisher:* Academic Press.

Progressive Education Society's
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First Year of B.Sc. Data Science
Course under NEP 2025-26

Course Code: 24CsDscU1104
Course Name: Lab Course on Descriptive Statistics
Teaching Scheme: TH: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks Prerequisite**

Courses:

- Basic Mathematics.

Course Objectives:

- To learn graphical representation, summary statistics of the data.
- To Study the concept of Skweness, Kurtosis and correlation.
- To learn attributes and its measure of association.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Represent data using tables, charts, and graphs.	2
CO 2	Compute and interpret measures of central tendency and dispersion.	3
CO 3	Apply appropriate statistical measures to different data sets.	3
CO 4	Compute measures of skewness and kurtosis.	3
CO 5	Analyze correlation between variables using appropriate methods.	4
CO 6	Evaluate attributes and measures of association for categorical data.	5

Course Contents

Sr. No.	Title of Experiment/ Practical
1	Diagrammatic and Graphical representation of statistical data-I: Bar diagram, Histogram, Stem and leaf.
2	Diagrammatic and Graphical representation of statistical data-II: Frequency Polygon, Frequency curve, Ogive curve (less and more than type)
3	Diagrammatic and Graphical representation of statistical data-III: Pie chart, Sub-divided bar diagram, Multiple bar diagram, Dual axis plot

4	Computation of measures of central tendency and dispersion (ungrouped data). Use of an appropriate measure and interpretation of results and computation of partition values.
5	Computation of measures of central tendency and dispersion (grouped data)-I Use of an appropriate measure and interpretation of results and computation of partition values.
6	Computation of measures of central tendency and dispersion (grouped data)-II Use of an appropriate measure and interpretation of results and computation of partition values.
7	Measures of Skewness, Kurtosis based quartiles, Box and Whisker plot and detection of outliers.
8	Moments, Measures of Skewness, Kurtosis based moments.
9	Scatter diagram, computation of correlation coefficient
10	Computation of Spearman's Rank Correlation Coefficient.
11	Represent Attributes data in contingency table, Computation of frequencies of attributes.
12	Check Consistency of data, independence of attributes, Computation of Yule coefficient of association and it's interpretation.
13	Project work (equivalent to 3 practicals)

Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune – 5

First Year of B.Sc. Data Science
Course under NEP 2025-26

Course Code : 24CsDscU1105
Course Name : Computational Mathematics
Teaching Scheme: TH: 2 Hours/Week **Credit : 02**

Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Prerequisites: Vectors, Functions, Polynomials, Matrices, Determinant.

Course Objectives: To study

- Determinants
- System of linear equations
- Linear transformations
- Eigen values and Eigenvectors.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Compute determinants of matrices using standard methods.	3
CO 2	Derive echelon form of matrices and apply LU decomposition.	3
CO 3	Solve systems of linear equations using various methods.	3
CO 4	Verify whether a given transformation is linear.	4
CO 5	Apply Rank-Nullity Theorem to linear transformations.	4
CO 6	Calculate eigenvalues and eigenvectors and examine diagonalizability of matrices.	4
CO 7	Represent quadratic forms in matrix form and vice versa.	3
CO 8	Apply linear algebra concepts to solve real-world problems.	6

Course Contents:

Chapter 1	**Determinants**	**04 hours**
	• Determinants by Cofactor Expansion • Evaluating Determinants by Row Reduction • Properties of the Determinant Function	
Chapter 2	**System of linear equations**	**10 hours**
	• Introduction to System of Linear Equations • Row reduction and echelon form of a matrix • LU Decomposition of a Matrix • Gauss elimination method • Gauss –Jordan elimination method	
chapter 3	**Linear Transformations**	**10 hours**
	• Euclidean n-Space • General Linear Transformations. • Kernel and Range • Rank Nullity Theorem • Matrix of general Linear Transformations.	
Chapter 4	**Eigen values and Eigenvectors**	**06 hours**
	• Eigen values and Eigenvectors. • Diagonalization.	
	Total No. of Hours	**30**

Reference Books:

1) Elementary Linear Algebra (Applications Version) by Howard Anton, Chriss Rorres, John Wiley and Sons Inc.(Ninth edition), 2010 .

2) Linear Algebra and Its Applications by David Lay, Steven Lay and Judi McDonald, Pearson, Fifth edition.

3) Introduction to Linear Algebra, S. Lang, Springer-Verlag (Second edition), 1986.

4) Linear Algebra by K. Hoffmann and R. Kunze, Prentice Hall of India (Second edition), 1998.

Progressive Education Society's
Modern College of Arts, Science and Commerce,
Shivajinagar, Pune – 5

First Year of B.Sc. Data Science
Course under NEP 2025-26

Course Code: 24CsDscU1106
Course Name: Lab Course on Computational Mathematics

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisites: Vectors, Functions, Polynomials, Matrices, Determinant.
Prerequisites: Vectors, Functions, Polynomials, Matrices, Determinant.

Course Objectives: To study

- Determinants
- System of linear equations
- Linear transformations
- Eigen values and Eigenvectors.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Implement computations of determinants, matrices, and polynomials using software tools.	3
CO 2	Apply row reduction, echelon form, and LU decomposition in practice.	3
CO 3	Solve systems of linear equations using Scilab/Python.	3
CO 4	Compute eigenvalues, eigenvectors, and verify diagonalization.	3
CO 5	Demonstrate linear transformations and Rank-Nullity theorem practically.	4
CO 6	Use Python/Scilab to visualize transformations and projections.	4
CO 7	Apply linear algebra methods to solve applied case studies.	6

Course Contents:

	List of Practical	60 Hours
Practical 1	Determinants	
Practical 2	Matrices using Scilab	
Practical 3	Echelon form and LU decomposition of a Matrix	
Practical 4	System of linear equation	
Practical 5	System of linear equations using Scilab	
Practical 6	Polynomials using Scilab	
Practical 7	Graphs of functions using Scilab/Geogebra	
Practical 8	Eigen values and Eigenvectors	
Practical 9	Eigen values and Eigenvectors using Scilab	
Practical 10	Linear transformation	
Practical 11	Rank-Nullity Theorem	
Practical 12	Applications of Linear Algebra	
Practical 13	Two dimensional transformations using Python	
Practical 14	Three dimensional transformations using Python	
Practical 15	Projections using Python	

Note: For every batch there will be 4 hours for each practical session per week.

Reference Books:

1) Elementary Linear Algebra (Applications Version) by Howard Anton, Chriss Rorres, John Wiley and Sons Inc. (Ninth edition), 2010.
2) Linear Algebra and Its Applications by David Lay, Steven Lay and Judi McDonald, Pearson, Fifth edition.
3) Introduction to Linear Algebra, S. Lang, Springer-Verlag (Second edition), 1986.
4) Linear Algebra by K. Hoffmann and R. Kunze, Prentice Hall of India (Second edition), 1998.

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First Year of B.Sc. Data Science
Course under NEP 2025-26

Course Code: 24CsDscU1601
Course Name: Software Engineering

Teaching Scheme: PR: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite Courses:

- Computer Fundamentals
- Problem solving and programming in C

Course Objectives:

- To study phases in a software project
- To learn the fundamental concepts of requirements engineering and Analysis Modeling.
- To study the various software design methodologies

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Identify unique features of various software application domains and classify software applications.	2
CO 2	Select and apply appropriate software development life cycle models.	3
CO 3	Analyze software requirements using structured analysis and modeling techniques.	4
CO 4	Evaluate agile methodologies in contrast to traditional models.	5
CO 5	Demonstrate understanding of software engineering phases through case studies.	3

Course Contents:

Unit No.	Title	Lectures
Unit 1	**Software and Software Engineering**	**4 lectures**

	1. The Nature of Software • Defining Software • Software Application Domain • Legacy Software 2. Software Engineering 3. McCall's Quality Factors	
Unit 2	**System Development Life Cycle (SDLC)**	**6 lectures**
	1. Introduction 2. Activities of SDLC • Preliminary Investigation (Request Clarification, Feasibility Study, Request Approval) • Determination of System Requirements • Design of system • Development of Software • System Testing (Unit Testing, Integration testing, System Testing) • System Implementation & Evaluation • System Maintenance o Definition and types o Software Reengineering o Reverse Engineering o Restructuring and forward Engineering	
Unit 3	**Process Models**	**6 lectures**
	1. A Generic Process Model 2. Prescriptive Process Models • The Waterfall Model • Incremental Process Models o RAD Model • Evolutionary Process Models o Prototyping o Spiral Model	
Unit 4	**Requirements Engineering**	**4 lectures**
	1. Introduction 2. Requirements Engineering Task • Inception • Elicitation • Elaboration • Negotiation • Specification • Validation • Requirements Management 3. Feasibility Study 4. Fact Finding Techniques • Questionnaire • Interview • Record Review • Observation	
Unit 5	**Structured Analysis and Design Tools**	**6 lectures**

	1. Structured Analysis • What is Structured Analysis? • Components of Structured Analysis • What is Data Flow Analysis? 2. Features& Tools of Data Flow Analysis • Logical Data Flow Diagram (Logical DFD)	
	• Notations • Drawing a Context Diagram • Exploding A Context diagram into Greater detail (1st level, 2nd Level DFD etc…) 3. E-R Diagram 4. Case Study 5. Concept of Data Dictionary	
Unit 6	**An Agile View of Process**	**4 lectures**
	1. What is an Agility? 2. What is an Agile Process? 3. Agile Process Models • Extreme Programming (XP) • Adaptive Software Development (ASD) • Dynamic Systems Development Method (DSDM)	

Note: *Case Study* should be considered as a part of *Internal Evaluation*

Reference books:

1. Software Engineering: A Practitioner's Approach by Roger S Pressman, Mcgraw-Hill, Seventh or 8th Edition, ISBN: 0073375977.
2. System analysis and Design of Information system by James Senn, McGraw-Hill, 2nd Edition, ISBN-10: 0070562369 ISBN-13: 978-0070562363
3. System Analysis, Design & introduction to Software Engineering(SADSE) by Parthsarthy, Khalkar., Everest Publishing House, 10th or 14th edition ISBN no. 978-81- 7660- 290-7

Semester II

Progressive Education Society's

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First Year of B.Sc. (Data Science)

(2025 Course under NEP 2020)

Course Code: 24CsDscU2101

Course Name: Advanced Python programming

Teaching Scheme: Th: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

CO No	Course Outcomes (COs)	Blooms Cognitive level
CO 1	Write efficient and optimized Python code.	1
CO 2	Implement object-oriented programming (OOP) principles.	2
CO 3	Utilize advanced data structures and algorithms.	3
CO 4	Work with concurrent programming and parallel execution.	4
CO 5	Apply Python in real-world applications like web scraping, data science, and automation.	5

Unit 1	**Advanced Data Structures & Algorithms**	**05 lectures**
	1.1 List, Set, Dictionary Comprehensions 1.2 Namedtuples, defaultdict, Counter, OrderedDict 1.3 Heapq, deque, and other collections 1.4 Generators and Iterators 1.5 Sorting Techniques and Custom Sorting 1.6 Time Complexity Analysis	
Unit 2	**Object-Oriented Programming (OOP) in Python**	**05 lectures**
	2.6 Class and Object Basics 2.7 Encapsulation, Inheritance, and Polymorphism 2.8 Abstract Classes and Interfaces (ABC module) 2.9 Magic Methods & Operator Overloading 2.10 Metaclasses and Custom Classes	
Unit 3	**Functional Programming**	**05 lectures**
	3.6 Lambda Functions, Map, Reduce, Filter 3.7 Decorators and Higher-Order Functions	

	3.8 Closures and Currying 3.9 Using functools (lru_cache, partial, wraps) 3.10 List Comprehension vs Generator Expressions	
Unit 4	**Concurrency and Parallelism**	**05 lectures**
	4.6 Threading and Multiprocessing 4.7 Asyncio and Event Loop 4.8 GIL (Global Interpreter Lock) 4.9 Performance Optimization in Multithreading 4.10 Distributed Computing with Python	
Unit 5	**File Handling and Database Connectivity**	**05 lectures**
	5.5 Handling Files, JSON, and CSV Data 5.6 Using SQLite and SQLAlchemy 5.7 Working with NoSQL Databases (MongoDB, Redis) 5.8 Data Serialization (Pickle, JSON, XML)	
Unit 6	**Advanced Python Applications**	**06 lectures**
	6.3 Web Scraping with BeautifulSoup & Selenium 6.4 API Integration with Requests and FastAPI 6.5 Python for Data Science (NumPy, Pandas) 6.6 Automation using Python	

Reference Books:

1. Python Programming using problem solving approach by Reema Thareja, Oxford University Press.2017,ISBN-10 : 0199480176; ISBN-13 : 978-0199480173
2. Introduction to Computation and Programming Using Python with application to understanding data by Guttag John V.PHI, ISBN-10 : 0262519631; ISBN-13 : 978-0262519632

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FY.B.Sc.. (Data Science)
(2025 Course under NEP)

Course Code: 24CsDscU1102
Course Name: Lab Course on Advanced Python Programming

Teaching Scheme:PR: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Implement advanced data structures and algorithms using Python.	3
CO 2	Develop programs using OOP concepts including inheritance and polymorphism.	3
CO 3	Apply functional programming paradigms to solve problems.	3
CO 4	Implement concurrency using threading, multiprocessing, and asyncio.	3
CO 5	Perform database connectivity and file handling in Python.	3
CO 6	Develop real-world projects using web scraping, APIs, and automation tools.	6

Course Contents:

Sr.No	List of practical
1	Advanced Data Structures & Algorithms • Implement list, set, and dictionary comprehensions. • Use namedtuples, defaultdict, and Counter from the collections module. • Implement sorting algorithms using sorted() with lambda functions. • Use heaps (heapq) and double-ended queues (deque).

2	**Object-Oriented Programming (OOP) in Python** • Create classes with encapsulation, inheritance, and polymorphism. • Implement operator overloading (e.g., _____add___, ___sub___). • Work with abstract classes using ABC module. • Develop a mini-project using OOP concepts.
3	**Functional Programming** • Use lambda functions, map, reduce, and filter. • Implement decorators and higher-order functions. • Work with functools (e.g., lru_cache, partial).
4	**Concurrency and Parallelism**

	• Implement multi-threading using threading module. • Use multiprocessing for parallel execution. • Work with asynchronous programming (asyncio).
5	**File Handling & Database Connectivity** • Read/write files in different formats (CSV, JSON, XML). • Implement SQLite connectivity using sqlite3. • Work with MongoDB using pymongo.
6	**Web Scraping & APIs** • Scrape data using BeautifulSoup and requests. • Automate browser tasks using Selenium. • Consume REST APIs using requests and FastAPI.

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First Year of B.Sc. Data Science
(Course under NEP 2025-26)

Course Code: 24CsDscU1103
Course Name: Discrete Probability Distributions
Teaching Scheme: TH: 2 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Course Objectives: To Introduce to students:

- the basic concepts of probability, axiomatic approach of probability, concept of independence of two events, conditional probability and Bayes law
- the concept of random variable and univariate probability distribution.
- the concept of independence of variables involved.
- Standard discrete probability distributions based on finite and infinite sample space.
- Interrelations between Standard discrete probability distributions.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Differentiate between random and non-random experiments.	2
CO 2	Apply concepts of probability, conditional probability, and independence of events.	3
CO 3	Use Bayes' theorem to compute probabilities in real situations.	3
CO 4	Define random variables and construct their probability distributions.	1
CO 5	Analyze and apply standard discrete probability distributions in real-life contexts.	4
CO 6	Evaluate limiting distributions and their applications.	5

Course Contents:

Unit 1	Probability	08L
	1.1 Definitions of - (i) Sample space, (ii) Discrete sample space (finite and countably infinite) (iii) Continuous sample space, (iv) Events, (v) Elementary event, (vi) Complement of an event, (vii) Certain event, (viii) Impossible event. etc. 1.2 Concept of occurrence of an event, Algebra of events. 1.3 Classical definition of probability and its limitations. 1.4 Probability model, equiprobable and non-equiprobable sample space. 1.5 Axiomatic definition of probability, theorems on probability, computation of probability of an event. 1.6 Conditional probability and Independence of two events. 1.7 Pair-wise independence and mutual independence for three events. Multiplication theorem for two events. 1.8 Partition of the sample space. Bayes' theorem (Statement only), and its applications.	
Unit 2	**Univariate Probability Distributions**	05 L
	Concept and definition of a discrete random variable. 2.2 Probability mass function (p.m.f.) and distribution function (d.f.), $F_X(\cdot)$, of discrete random variable, Characteristic properties of distribution function. 2.3 Mode and median of a univariate discrete probability distribution. Definition of expectation (mean) of a random variable its properties, moment generating function (m.g.f.) and cumulant generating function(c.g.f.). 2.4 Definitions of variance and its properties. standard deviation (s.d.) and coefficient of variation (c.v.) of univariate probability distribution Definition of raw, central moments and factorial raw moments of univariate probability distributions and their interrelations. Examples and problem	
Unit 3	**Discrete Probability Distributions based on finite sample space**	10L
	3.1 Degenerate distribution (one point distribution) P.m.f.: P(X=c) =1, mean and variance. 3.2 Uniform discrete distribution on integers 1 to n: p.m.f. $P(X=x) = \begin{cases} \frac{1}{n} & , x = 1, 2, \cdots, n. \\ 0 & \text{otherwise}. \end{cases}$ mean, variance, M.G.F, distribution of sum of two discrete uniform random variable. variance, real life situations, comments on mode andmedian. 3.3 Bernoulli distribution: p.m.f.	

	$P(X=x)=\begin{cases} p^x(1-p)^{1-x} & ,x=0,1 \\ & 0<p<1 \\ 0 & \text{otherwise} \end{cases}$ mean, variance, M.G.F. and moments. Distribution of sum of two independent Bernoulli random variable. 3.4 Binomial distribution: p.m.f. $P(X=x)=\begin{cases} \binom{n}{x} p^x q^{(n-x)} & ,x=0,1,\ldots,n. \\ & ,0<p<1 \quad ,q=1-p \\ 0 & \text{otherwise}. \end{cases}$ Notation: X ~B(n,p). , situations where this distribution is applicable. mean, variance, recurrence relation for successive probabilities, computation of probabilities of different events, mode of the distribution, m.g.f., moments, skewness (comments when p = 0.5, p > 0.5, p < 0.5), additive property (statements only) 3.5 Hypergeometric Distribution: p.m.f $P(X=x)=\begin{cases} \dfrac{\binom{M}{x}\binom{N-M}{n-x}}{\binom{N}{n}} & ,x=0,1,\cdots\cdots \min\{n,M\}, N>M \\ 0 & \text{otherwise} \end{cases}$ Notation: X ~H (N, M, n), situations where this distribution is applicable 3.6 Mean and variance, binomial approximation to hypergeometric distribution (Statement only). Computation of probability, 3.7 Examples and problems.	
Unit 4	**Univariate discrete probability distributions based on countably infinite sample space.**	07 L
	4.1 **Poisson distribution**: Notation: X ~P(λ). $p(x)=\begin{cases} \dfrac{e^{-\lambda}\lambda^x}{x!} & , \quad x=0,1,2\ldots\ldots, \quad \lambda>0 \\ 0 & \text{otherwise} \end{cases}$ Situations where this distribution is applicable. Mean, variance. m.g.f, moments, skewness, kurtosis, recurrence relation, conditional distribution X | X + Y , additive property, Poisson distribution as a limiting form of binomial distribution (Statement only). 4.2 **Geometric distribution**: Notation: X ~G(p), Geometric distribution on support (0, 1, 2…) , with p.m.f.	

$$p(x) = \begin{cases} pq^x, & x = 0, 1, 2\ldots, 0 < p < 1,\ q = 1 - p. \\ 0 & \text{otherwise} \end{cases}$$

Geometric distribution on support (1,2,...)with p.m.f.

$$p(x) = \begin{cases} pq^{x-1}, & x = 1, 2\ldots \quad 0 < p < 1,\ q = 1 - p. \\ 0 & \text{otherwise} \end{cases}$$

distribution function, recurrence relation, situations where this distribution is applicable. Mean, variance. m.g.f , moments , lack of memory property. Examples and problems

4.3 **Negative Binomial Distribution**:

Probability mass function (p.m.f.)

$$P(X = x) = \binom{x+k-1}{x} p^k q^x \quad ; x = 0,1,2, \ldots \ ; 0 < p < 1 \ ; q = 1 - p \ ; k > 0$$
$$= 0 \quad ; \quad otherwise.$$

Notation: $X \sim NB(k, p)$.

Nature of p. m. f. negative binomial distribution as waiting time distribution. M.G.F. (State the formula only)., mean, variance, Relation between geometric and negative binomial distribution. Poisson approximation to negative binomial distribution (Statement only). Real life situations.

References:

1. Gupta, S. C. and Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics, 10th Edition, Sultan Chand and Sons Publishers, New Delhi.
2. Agarwal B. L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, New Delhi.
3. B.L.S. Prakasarao, (2008). A First Course in Probability and Statistics, World Scientific Publishing Company.
4. Ross S. (2002). A First Course in Probability, 6th edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc.
5. *Roussas*, George G. (2016). First course in mathematical *statistics*.2nd edition *Publisher:* Academic Press.
6. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. 1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
7. Mukhopadhyay P. (2015). Applied Statistics, *Publisher*: Books & Allied (*P*) Ltd.

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First Year of B.Sc. Data Science
(Course under NEP 2025-26)

Course Code: 24CsDscU1104
Course Name: Lab course on discrete probability distributions.
Teaching Scheme: TH: 4 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Pre-requisites: Knowledge of the topics in Major theory (section I and II)

- **Course outcome:**

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Solve problems on permutations, combinations, and probability.	3
CO 2	Apply conditional probability and independence in problem solving.	3
CO 3	Fit and evaluate binomial, Poisson, and negative binomial distributions.	3
CO 4	Apply probability distributions to real-life scenarios.	4
CO 5	Simulate and model sampling from discrete distributions.	4
CO 6	Develop mini-projects using probability distribution concepts.	6

Sr.No.	Title of Experiment/ Practical
1	Problems on permutations and combinations- I
2	Problems on permutations and combinations- II
3	Problems on probability and conditional probability I
4	Problems on probability and conditional probability II
5	Problems of independence and Bayes' theorem.
6	Fitting of binomial distribution and computation of expected frequencies.
7	Fitting of Poisson distribution and computation of expected frequencies.
8	Fitting of negative binomial distribution and computation of expected frequencies
9	Applications of Bernoulli and binomial distribution.
10	Applications of uniform and Poisson distribution.

11	Applications of hypergeometric distribution.
12	Applications of negative binomial and geometric distribution.
13	Model sampling from binomial, Poisson, Discrete Uniform distribution.
14	Model sampling from Geometric and Negative Binomial distribution.
15	Project

Sr.No.	Title of Experiment/ Practical
1	Problems on permutations and combinations- I
2	Problems on permutations and combinations- II
3	Problems on probability and conditional probability I
4	Problems on probability and conditional probability II
5	Problems of independence and Bayes' theorem.
6	Fitting of binomial distribution and computation of expected frequencies.
7	Fitting of Poisson distribution and computation of expected frequencies.
8	Fitting of negative binomial distribution and computation of expected frequencies
9	Applications of Bernoulli and binomial distribution.
10	Applications of uniform and Poisson distribution.
11	Applications of hypergeometric distribution.
12	Applications of negative binomial and geometric distribution.
13	Model sampling from binomial, Poisson, Discrete Uniform distribution.
14	Model sampling from Geometric and Negative Binomial distribution.
15	Project

Progressive Education Society's
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First Year of B.Sc. Data Science
(Course under NEP 2025-26)

Course Code: 24CsDscU2105
Course Name: Graph Theory
Teaching Scheme: TH: 2 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Set Theory

Course Objectives: To Study

- Graphs, types of graphs.
- Operations on graphs viz. Union, Intersection, Ring Sum and Product.
- Connected graphs and its properties.
- Trees and their properties.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Formulate real-life problems as graph models.	2
CO 2	Test graph isomorphism and apply basic operations on graphs.	3
CO 3	Analyze connectivity and shortest path problems in graphs.	4
CO 4	Apply tree traversal techniques and spanning tree algorithms.	3
CO 5	Evaluate spanning tree algorithms such as Kruskal's and Prim's.	5
CO 6	Solve applied problems using graph-theoretic concepts.	6

Course Contents:

Chapter 1	**Graphs**	4 Hours
	• **Graphs as Models.** • **Types of graphs.** • **Isomorphism.** • **Adjacency and Incidence Matrix of a Graph.**	
Chapter 2	**Operations on Graphs**	6 Hours
	• **Subgraphs, Induced subgraphs.**	

	● **Vertex deletion, Edge deletion.** ● **Complement of a graph.** ● **Union and Intersection.** ● **Ring Sum and Product of graphs.** ● **Fusion of vertices.**	
Chapter 3	**Connected Graphs.**	10 Hours
	● **Walk, Trail, Path and Cycle.** ● **Connected Graphs.** ● **Distance between two vertices, eccentricity, center, radius and diameter of a graph.** ● **Isthmus and Cutvetex.** ● **Cutset, edge-connectivity, vertex connectivity.** ● **Weighted Graphs.** ● **Dijkstra's Algorithm.**	
Chapter 4	**Trees**	10 Hours
	● **Trees.** ● **Center of a tree.** ● **Binary Tree.** ● **Tree Traversals.** ● **Spanning Tree.** ● **Kruskal's Algorithm.**	
	Total No. of Lectures	**30**

Reference Books:

1) A First Look at Graph Theory by John Clark and Derek Holton, Allied Publishers (1st Indian edition), 1995.

2) Graph Theory with Applications to Computer Science and Engineering by Narsingh Deo, Prentice Hall of India (3rd Indian edition), 1986.

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First Year of B.Sc. (Data Science)

(2025 Course under NEP 2020)

Course Code: 24CsDscU2106

Course Name: Lab Course on Graph Theory

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Semester: 30 Marks**

Prerequisite: Set Theory

Course Objectives: To Study

- Graphs, types of graphs.
- Operations on graphs viz. Union, Intersection, Ring Sum and Product.
- Connected graphs and its properties.
- Trees and their properties.

Course Outcomes:

CO No	Course Outcomes (COs)	Bloom's Cognitive Level
CO 1	Construct and analyze matrices of graphs.	3
CO 2	Perform graph operations and verify isomorphism.	3
CO 3	Apply algorithms to determine eccentricity, center, and diameter of graphs.	3
CO 4	Implement shortest path algorithms (Dijkstra's, TSP, Chinese Postman).	3
CO 5	Apply tree traversal and spanning tree algorithms practically.	3
CO 6	Develop solutions for applied case studies in graph theory.	6

Course Contents:

	List of Practical	**60 Hours**
Practical 1	Graphs.	
Practical 2	Matrix of a Graph.	
Practical 3	Operations on Graphs.	
Practical 4	Isomorphism of Graphs.	
Practical 5	Eccentricity, center, radius and diameter of a graph.	
Practical 6	Dijkastra's Algorithm.	
Practical 7	Connectivity.	
Practical 8	Chinese Postman Problem.	
Practical 9	Travelling Salesman Problem.	
Practical 10	Trees	
Practical 11	Fundamental Circuits and cutsets	
Practical 12	Tree Traversal algorithms	
Practical 13	Binary tree	
Practical 14	Kruskal's and Prim's algorithms	
Practical 15	Directed Graphs	

Reference Books:

1) A First Look at Graph Theory by John Clark and Derek Holton, Allied Publishers (1st Indian edition), 1995.

2) Graph Theory with Applications to Computer Science and Engineering by Narsingh Deo, Prentice Hall of India (3rd Indian edition), 1986.