(Formerly University of Pune)

Bachelors Degree in Data Science

(Faculty of Science and Technology)



Syllabi for B.Sc. (Data Science)

(For Colleges Affiliated to Savitribai Phule Pune University)

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

To be implemented from Academic Year 2024-2025

Preamble

Welcome to the B.Sc.(Data Science) programme! This programme is designed to empower students with knowledge and skills required to thrive in an era of data science and technology. By choosing B.Sc. (Data Science) Programme, students enter into the dynamic field of data science and data analytics. Students will engage and build strong foundation in mathematics, statistics, computer science and ethical data practices. This programme not only equips students with technical expertise but also fosters a mindset of continuous learning, adaptability and ethical leadership.

As you navigate this syllabus, consider it a roadmap to your future in data science. Welcome to the world where data becomes insight and insight drives innovation.

Eligibility

- (a) Higher Secondary School Certificate (10+2) Science Stream or its equivalent examination
 OR
- (b) Three Years Diploma Course after S.S.C. (10th standard) of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

Programme Outcomes:

- PO 1: The programme seeks to develop strong foundation in Mathematics, Statistics and Computer Science that demonstrate proficiency in basic programming languages and tools.
- PO 2: The programme aims to understand the principles of data storage and retrieval by acquiring knowledge of data type structures and basic data manipulation techniques.
- PO 3: The programme helps to learn database management techniques with design and management of databases as well as executing SQL queries for data retrieval and manipulation.
- PO 4: By applying advanced statistical methods and machine learning techniques, the students can analyze complex datasets, interpret and communicate findings effectively.
- PO 5: The programme also aims to understand and work with big data technologies and apply these technologies to process and analyze large-scale datasets.
- PO 6: The students can create clear and effective data visualizations using various tools and communicate complex findings through visual representations.
- PO 7: The programme also seeks to develop comprehensive projects by applying data science techniques to solve real-world problems that will improve the ability of learner to integrate knowledge and skills acquired throughout the programme.

- PO 8: Through hands-on projects, practical assignments, and exposure to state-of-the-art tools and technologies, programme aim to develop the technical proficiency and problem-solving skills necessary for success in the professional world.
- PO 9: Depending on the chosen track, students can develop expertise in data analytics with areas such as Business, Social Media, HR, Financial, Healthcare, Supply Chain & Logistics and Big Data etc.
- PO 10: The program include On Job Training, internships and research work that provides learners with practical experience, applying their knowledge to real-world challenges.
- PO 11: Graduates will be adept at presenting complex technical concepts clearly and effectively, both in written and oral forms, to various audiences.
- PO 12: The programme places a strong emphasis on ethical considerations, responsible use of technology, and awareness of the societal impact of data science and computing solutions.
- PO 13: The programme aim to produce graduates who approach their work with integrity and a sense of social responsibility.
- PO 14: Acknowledging the dynamic nature of computer science, the programme aim to inspire students for continuous learning and professional development, empowering them to adapt and thrive in the face of technological advancements; prepared them to adapt to new technologies and methodologies throughout their careers.
- PO 15: The students will be encouraged to think creatively and innovatively, exploring new ideas and approaches to solve data science related problems and advance the state of the art in the field.

Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25

FY (Level 4.5) SEMESTER I

Course	Course	Course Name	Cre	dits	Teach Sche Hrs/W	ning me Veek	Ex Sc	kamin chemo Mar	ation e and ks
туре	coue		T H	P R	ТН	PR	C E	E E	Total
Subject- 1	DS101T	Problem Solving and Python Programming	2	-	2	-	15	35	50
	DS102P	Lab Course on DS101T (Python Programming)	-	2	-	4	15	35	50
Subject	DS103T	Descriptive Statistics	2	-	2	-	15	35	50
2	DS104P	Lab Course on DS103T (Descriptive Statistics)	-	2	-	4	15	35	50
Subject-	DS105T	Computational Mathematics	2	-	2	-	15	35	50
3	DS106P	Lab Course on DS105T (Computational Mathematics)	-	2	-	4	15	35	50
GE/OE	OE101DS	Office Automation/ Computer Fundamentals/ Introduction to Google Tools	2	-	2	-	15	35	50
SEC	SEC101DS	Computer Organization	2	-	2	-	15	35	50
IKS	DS101IKS	Indian Knowledge System (Generic)	2	-	2	-	15	35	50
AEC	AEC101 MAR/HIN/ ENG	MIL-I (Hindi) / MIL-I (Marathi)/ MIL-I (English)	2	-	2	-	15	35	50
VEC	VEC101 ENV	EVS-I	2	-	2	-	50	-	50
Total			16	6	16	12			550

Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25

FY (Level 4.5) SEMESTER II

					Tea	ching	Ex	amir	ation
Course	Course		Cre	dits	Sch	neme	So	chem	e and
Type	course	Course Name			Hrs/	Week		Mar	ks
Type	coue		T H	P R	ТН	PR	C E	E E	Total
Subject	DS151T	Advanced Python Programming	2	-	2	_	15	35	50
1	DS152P	Lab Course on DS151T (Advanced Python Programming)	-	2	-	4	15	35	50
Subject	DS153T	Discrete Probability and Probability Distributions	2	-	2	-	15	35	50
2	DS154P	Lab Course on DS153T (Discrete Probability and Probability Distributions)	-	2	-	4	15	35	50
Subject-	DS155T	Graph Theory	2	-	2	-	15	35	50
3	DS156P	Lab Course on DS155T (Graph Theory)	-	2	-	4	15	35	50
GE/OE	OE151DSP	Office Automation/ Computer Fundamentals/ Introduction to Google Tools	-	2	-	4	15	35	50
SEC	SEC151DS	Lab Course on Excel and Advanced Excel	-	2	-	4	15	35	50
AEC	AEC101 MAR/HIN/ ENG	MIL-I (Hindi) / MIL-I (Marathi)/ MIL-I (English)	2	-	2	-	15	35	50
VEC	VEC101 ENV	EVS-II	2	-	2	-	50	-	50
CC	CC151PE/ NSS/ NCC	From University Basket	2	-	2	-	50	-	50
Total		12	10	12	20			550	

Savitribai Phule Pune University Syllabus Structure as per NEP Guidelines B.Sc. (Data Science) from 2024-25

SY (Level 5.0) SEMESTER III

Course Type	Course code	Course Name	Credits		Teacl Sche	hing eme	Ex Sc	amin hemo	ation e and
					Hrs/V	Veek		Mar	ks
			Т	Р	TH	PR	С	Ε	Total
			Η	R			Ε	Ε	
	DS201MJ	Database Management System	2	-	2	-	15	35	50
Major	DS202MJ	Data Structure-I	2	-	2	-	15	35	50
Core	DS203MJP	Lab Course on DS201MJ and DS202MJ	-	2	-	4	15	35	50
VSC	DS221VSC	Foundations of Data Science	2	-	2	-	15	35	50
FP/	DS231FP		-	2	-	4	15	35	50
OJT/		Mini Project							
СЕР									
	DS241MN	Probability Distribution and	2	-	2	-	15	35	50
Minor		Modelling							
	DS242MNP	Lab Course on DS241MN	-	2	-	4	15	35	50
GE/OF	OE201DS	Ecommerce/ Web Design/	2	-	2	-	15	35	50
UE/UE		Digital Marketing							
IKS	DS201IKS	Computing in Ancient India	2	-	2	-	15	35	50
AEC	AEC201ENG	Soft Skills-I	2	-	2	-	15	35	50
CC	CC201PE/	From University Basket	-	2	-	4	50	-	50
	NSS/ NCC								
	Total				14	16			550

Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25

Course	Course code	Course Name	Credits		Teac	hing	Ex	Examination		
Туре					Sch	eme	Sc	hem	e and	
					Hrs/Week		Marks		·ks	
			Т	PR	TH	PR	С	E	Total	
			Η				Ε	Е		
	DS251MJ	Relational Database	2	-	2	-	15	35	50	
		Management System								
Major Core	DS252MJ	Data Structure-II	2	-	2	-	15	35	50	
	DS253MJP	Lab Course on DS251MJ and DS252MJ	-	2	-	4	15	35	50	
VSC	DS221VSC	Data Analytics	-	2	-	4	15	35	50	
FP/ OJT/ CEP	DS231FP	Mini Project	-	2	-	4	15	35	50	
Minor	DS241MN	Testing of Hypothesis and Sampling Distributions	2	-	2	-	15	35	50	
	DS242MNP	Lab Course on DS241MN	-	2	-	4	15	35	50	
GE/OE	OE251DSP	Ecommerce/ Web Design/	-	2	-	4	15	35	50	
SEC	SEC251DSD	Software Engineering	2		2		15	25	50	
SEC	SEC231DSP	Software Engineering		-	2	-	15	55	50	
AEC	AEC201ENG	Soft Skills-II	2	-	2	-	15	35	50	
CC	CC201PE/	From University Basket	-	2	-	4	50	-	50	
	NSS/ NCC									
		Total	10	12	10	24			550	

SY (Level 5.0) SEMESTER IV

Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25

TY (Level 5.5) SEMESTER V

Course	Course code	Course Name	Credits		Tea	ching	Ex	amir	ation
Туре					Sch	neme	So	chem	e and
					Hrs/	Week		Marks	
			Т	Р	TH	PR	C	Ε	Total
			Н	R			Ε	Ε	
	DS301MJ	NoSQL databases	4	-	4	-	30	70	100
	DS302MJ	R Programming	2	-	2	-	15	35	50
Major Core	DS303MJ	Foundations of Artificial Intelligence	2	-	2	-	15	35	50
	DS304MJP	Lab Course on DS301MJ (NoSQL databases)	-	2	-	4	15	35	50
	DS305MJP	Lab Course on DS302 (R Programming)	-	2	-	4	15	35	50
	DS310MJ	Business Analytics	2	-	2	-	15	35	50
Maior	DS311MJP	Lab Course	-	2	-	4	15	35	50
Elective	OR					-			
	DS312MJ	Social Media Analytics	2	-	2	-	15	35	50
	DS313MJP	Lab Course	-	2	-	4	15	35	50
VSC	DS321VSCP	Lab Course on MATLAB	-	2	-	4	15	35	50
FP/CEP	DS331FP	Mini Project	-	2	-	4	15	35	50
Minor	DS341MN	Categorical Data Analysis	2	-	2	-	15	35	50
	Total					20			550

Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25

Course	Course	Course Name	Credits		Teac	hing	Exa	Examination	
Туре	code				Sch	eme	Sc	Scheme and	
					Hrs/	Week	Marks		KS
			Т	Р	ТН	PR	CE	Ε	Total
			Н	R				Ε	
	DS351MJ	Data Visualization and	4	-	4	-	30	70	100
		Modelling							
	DS352MJ	Artificial Intelligence in Data	2	-	2	-	15	35	50
Major Core		Science							
	DS353MJ	Data Security and Privacy	2	-	2	-	15	35	50
	DS354MJP	Lab on DS351MJT	-	2	-	4	15	35	50
	DS355MJP	Lab Course on DS352MJ	-	2	-	4	15	35	50
	DS360MJ	HR Analytics	2	-	2	-	15	35	50
	DS361MJP	Lab Course	-	2	-	4	15	35	50
Major Elective	OR								
LIECUVE	DS362MJ	Financial Analytics	2	-	2	-	15	35	50
	DS363MJP	Lab Course	-	2	-	4	15	35	50
OJT	DS381OJT	On Job Training	-	4	-	8	30	70	100
Minor	DS391MN	Multivariate Analysis	2	-	2	-	15	35	50
		Total	12	10	12	20			550

TY (Level 5.5) SEMESTER VI

Savitribai Phule Pune University Syllabus Structure as per NEP Guidelines B.Sc. (Data Science) from 2024-25

(Level 6.0) SEMESTER VII (Honors with Research Degree)

Course	Course	Course Name	Credits		Tea	ching	Examination		
Туре	code				Scł	neme	Scheme and		
					Hrs/	Week	Marks		ks
			Т	T P		PR	С	Ε	Total
			Н	R			Е	Ε	
	DS401MJ	Machine Learning	4	-	4	-	30	70	100
Major	DS402MJ	Basics of Cloud Computing	2	-	2	-	15	35	50
Core	DS403MJP	Lab Course on DS401MJ	-	2	-	4	15	35	50
	DS404MJP	Lab Course on DS402MJ	-	2	-	4	15	35	50
	DS410MJ	Supply Chain & Logistics	2	-	2	-	15	35	50
		Analytics							
Major	DS411MJP	Lab Course	-	2	-	4	15	35	50
Elective	OR								
	DS412MJ	Healthcare Analytics	2	-	2	-	15	35	50
	DS413MJP	Lab Course	-	2	-	4	15	35	50
RP	DS431RP	Research Project	-	4	-	8	30	70	100
RM	DS441RM	Research Methodology	4	-	4	-	30	70	100
		Total	12	10	12	20			550

OR

(Level 6.0) SEMESTER VII (Honors Degree)

Course	Course	Course Name	Credits		Tea	ching	Examination		
Туре	code				Sch	neme	Scheme and		
					Hrs/	Week		Marks	
			T P		TH	PR	С	Ε	Total
			Η	R			Е	Ε	
	DS401MJ	Machine Learning	4	-	4	-	30	70	100
Major Core	DS402MJ	Basics of Cloud Computing	2	-	2	-	15	35	50
	DS403MJP	Lab Course on DS401MJ	-	2	-	4	15	35	50
	DS404MJP	Lab Course on DS402MJ	-	2	-	4	15	35	50
	DS405MJ	Big Data Analytics	4	-	4	-	30	70	100
	DS410MJ	Supply Chain & Logistics	2	-	2	-	15	35	50
		Analytics							
Major	DS411MJP	Lab Course	-	2	-	4	15	35	50
Elective	OR								
	DS412MJ	Healthcare Analytics	2	-	2	-	15	35	50
	DS413MJP	Lab Course	-	2	-	4	15	35	50
RM	DS441RM	Research Methodology	4	-	4	-	30	70	100
	Total					12			550

Savitribai Phule Pune University Syllabus Structure as per NEP Guidelines

B.Sc. (Data Science) from 2024-25 (Level 6.0) SEMESTER VIII (Honors with Research Degree)

Course	Course	Course Name	Credits		Teac	hing	Examination		
Туре	code				Scheme		Scheme and		
					Hrs/	Week	Marks		S
			T P		ТН	PR	С	EE	Tota
			Н	R			Ε		l
	DS451MJ	Data Mining and Warehousing	4	-	4	-	30	70	100
Major	DS452MJ	Deep Learning	2	-	2	-	15	35	50
Core	DS453MJP	Lab Course on DS451MJ	-	2	-	4	15	35	50
	DS454MJP	Lab Course on DS452MJ	-	2	-	4	15	35	50
	DS460MJ	Geospatial Technology	2	-	2	-	15	35	50
Malar	DS461MJP	Lab Course	-	2	-	4	15	35	50
Floctivo	OR								
Lieuwe	DS462MJ	E-Commerce	2	-	2	-	15	35	50
	DS463MJP	Lab Course	-	2	-	4	15	35	50
RP	DS481RP	Research Project	-	8	-	16	60	140	200
		Total	8	14	8	28			550

OR

(Level 6.0) SEMESTER VIII (Honors Degree)

Course	Course	Course Name	Credits		Tea	ching	Ex	ation	
Туре	code				Scł	neme	Scheme and		e and
					Hrs/	Week	Marks		ks
			Т	T P		PR	С	Ε	Total
			Η	R			Е	Ε	
	DS451MJ	Data Mining and Warehousing	4	-	4	-	30	70	100
Major Core	DS452MJ	Deep Learning	2	-	2	-	15	35	50
	DS453MJP	Lab Course on DS451MJ	-	2	-	4	15	35	50
	DS454MJP	Lab Course on DS452MJ	-	2	-	4	15	35	50
	DS455MJ	Natural Language Processing	4	-	4	-	30	70	100
	DS456MJ	Geospatial Technology	2	-	2	-	15	35	50
M - *	DS457MJP	Lab Course	-	2	-	4	15	35	50
Major	OR								
Elective	DS458MJ	E-Commerce	2	-	2	-	15	35	50
	DS459MJP	Lab Course	-	2	-	4	15	35	50
OJT	DS4810JT	On Job Training	-	4	-	8	30	70	100
		Total	12	10					550

SavitribaiPhulePuneUniversity B.Sc. Data Science (Pattern 2024) Semester-I

DS101T : Problem Solving and Python Programming

No. of C	redits: 2	Teaching Scheme	Examination Sch	ieme			
		Theory:2 Hrs /Week	Continuous Evalu	ation:15 Marks			
			End Semester:35	Marks			
Prerequi	isites						
• B	asic knowledge o	f mathematics, logic.					
• P	uzzle solving Apt	itude					
• K	nowledge of prol	olem solving tools like algorith	ms, flowcharts and pa	seudo codes will			
b	e an added advant	tage	Ĩ				
Objectiv	es	-					
• T	o teach students	systematic and efficient proble	m_solving methods	including problem			
• 1 ai	alvsis, algorithm	design, and solution impleme	ntation.	including problem			
• T	o provide a solic	l understanding of the Pytho	n programming langu	age including its			
5 1	vntax, data types	control structures and function	ns	inge, mendeling its			
• T	o instill good r	rogramming habits includin	g code readability	commenting and			
d	ocumentation.	nogramming months, monadmin	g coue readability,	commenting, and			
• T	o nurture the ab	ility to think algorithmically	and express solution	ns as step-by-step			
processes using Python programs.							
To learn and understand Object Oriented Programming							
• T	o improve debu	gging techniques and error i	dentification and cor	rection in Python			
p	rograms.	588					
Course	Jutaamas						
On Com	pletion of this cor	urse student will be able to					
	eate clear and effi	cient algorithms for solving a	variety of problems				
CO2· Wr	tite Python progra	ams to implement algorithms a	nd solve problems				
CO3: Ide	entify and correct	errors in Python programs using	ng systematic debuggi	ing techniques.			
CO4: Un	derstand Object (Driented Concepts in Python		ing teeningtees.			
CO5: Lea	arn and understan	d modules and packages in Pv	thon				
CO6: De	fine and demonst	rate the use of built-in data str	uctures "lists" and "di	ctionary".			
Unit		Name of Unit	Teaching	CO Targeted			
No.			Hours				
1	Introduction to	Problem Solving	5	CO 1			
1.1 What	is problem solvi	ng?	L	1			
1.2 Probl	em solving steps.	. O.					
1.3 Algor	rithms - definition	n, characteristics, examples, ad	vantages and limitation	ons.			
1.4 Flow	charts - definition	n, notations, examples, advant	ages and limitations,	Comparison with			
algor	ithms.						

1.5 Pseudo codes - notations, examples, advantages and limitations.

1.6 Introduction to Programming

1.7 Programming Languages as tools, programming paradigms, types of languages 1.8 Converting pseudo-code to programs.

1	Introduction to Python	10	CO1, CO2,
			CO3, CO6

1.1 History, feature of Python, setting up path, working with python Interpreter, basic syntax, variable and data types, operators

1.2 Conditional statements-If, If-Else, nested if-else, Examples.

1.3 Looping-For, While, Nested loops, Examples

1.4 Control Statements-Break, Continue, Pass.

1.5 String Manipulation-Accessing String, Basic Operations, String Slices, Function and Methods, Examples.

1.6 Lists-Introduction, accessing list, operations, working with lists, function & methods.

1.7 Tuple-Introduction, accessing tuples, operations working, function & methods, Examples.

1.8 Dictionaries-Introduction, Accessingvalues in dictionaries, working with dictionaries, properties, function, Examples.

1.9 Functions-Defining a function, Calling a function, types of function, function arguments, anonymous function, global & local variable, Examples

2 CI	asses, Objects and Inheritance	8	CO4			
2.1 Classes	2.1 Classes and Objects					
2.1.1 Classe	s as User Defined Data Type					
2.1.2 Object	s as Instances of Classes					
2.1.3 Creatin	ng Class and Objects					
2.1.4 Creatin	ng Objects By Passing Values					
2.1.5 Variab	les & Methods in a Class					
2.2 Inherita	ince					
2.2.1 Single	Inheritance					
2.2.2 Multile	evel					
2.2.3 Multip	le Inheritance					
2.2.4 Hybrid	l Inheritance					
2.2.5 Hierard	chical Inheritance					
2.2.6 IS-A R	Relationship and HAS-A Relationship					
3 M	odules and Packages	7	CO5			
3.1Built in I	Modules					
3.1.1 Import	ting modules in python program					
3.1.2 Workin	ng with Random Modules.					
3.1.3 E.g I	built-ins, time, date time, calendar, sys, etc					
3.2 User De	3.2 User Defined functions					
3.2.1Structu	re of Python Modules					
3.3 Package	es					
3.3.1 Predef	ined Packages					
3.3.2 User d	efined Packages					

- 1. How to solve it by Computer, R.G. Dromey, Pearson Education.
- 2. Mark Lutz, Programming Python, O'Reilly, 4th Edition, 2010
- 3. Dive into Python, Mike
- 4. Learning Python, 4th Edition by Mark Lutz
- 5. Programming Python, 4th Edition by Mark Lutz
- 6. Python Programming: An introduction to computer, John Zelle, 3rd Edition.
- 7. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016
- 8. Introduction to Python Programming. Gowrishankar S., Veena A. CRC Press, Taylor & Francis Group, 2019

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-I

DS102P : Lab Course on DS101T (Python Programming)

No. of Credits: 2	Teaching Scheme	Examination Sch	eme				
	Practical: 4 Hrs/Week	Continuous Evalua	tion: 15 Marks				
		End Semester:	35 Marks				
Prerequisites	1	1					
Basic knowledge o	of logic and Python programming	g concepts					
Knowledge of prol	blem solving tools like algorithm	s, flowcharts and pse	eudo codes will				
be an added advant	be an added advantage						
Objectives							
Learn Programmin	g fundamentals using Python						
• Understand the con	ncepts and usage data types, varia	ables and other basic	elements				
• Learn about using	operators and control statements	in Python					
• Learn about using	arrays and strings in Python.						
Learn Object Orier	nted concepts in Python.						
• Learn how to use r	nodules in packages in Python P	rogramming					
Course Outcomes							
On Completion of this cou	urse, students will be able to -						
CO1: Implement the use	e of built-in data structures "li	sts" and "dictionar	y" "Tuples" and				
"Sets".							
CO2; Implement program	s on Arrays and Strings						
CO3: Implement program	as on Object Oriented concepts in	n Python.	CO3: Implement programs on Object Oriented concepts in Python.				
CO4: Implement programs by importing modules and packages in Python.							
	as by importing modules and pack	kages in Python.					
Unit	Name of Unit	kages in Python. Hours	CO Targeted				
Unit No.	Name of Unit	kages in Python. Hours	CO Targeted				
Unit No. 1 Introduction to	Name of Unit Python Language	kages in Python. Hours 8	CO Targeted				
Unit No. 1 Introduction to a. Write a Python pro-	Name of Unit Python Language Ogram to explore various data type	kages in Python. Hours 8 pes including numer	CO Targeted CO1 ic types, Boolean				
Unit No. 1 Introduction to a. Write a Python prototypes and compound	Name of Unit Python Language ogram to explore various data typ nd types.	kages in Python. Hours 8 pes including numer	CO Targeted CO1 ic types, Boolean				
Unit No. 1 Introduction to a. Write a Python prototypes and compound b. Write a Python prototypes	Name of Unit Python Language Ogram to explore various data types. Ogram to perform Input and Outp	kages in Python. Hours 8 pes including numer ut Operations.	CO Targeted CO1 ic types, Boolean				
Unit No. 1 Introduction to a. Write a Python pro- types and compour b. Write a Python pro- c. write a Python pro- c. Write a Python pro- types	Name of Unit Python Language ogram to explore various data types. ogram to perform Input and Outp ogram to demonstrate looping i	kages in Python. Hours B ges including numer ut Operations. n python and use of	CO Targeted CO1 ic types, Boolean f break statement				
Unit No. 1 Introduction to a. Write a Python pro- types and compour b. Write a Python pro- c. Write a Python pro- c. Write a Python pro- and continue states	Name of Unit Python Language ogram to explore various data typ nd types. ogram to perform Input and Outp ogram to demonstrate looping i ment.	kages in Python. Hours 8 pes including numer ut Operations. n python and use of	CO Targeted CO1 ic types, Boolean f break statement				
Unit I No. 1 Introduction to a. a. Write a Python pro- types and compour b. Write a Python pro- c. Write a Python pro- and continue states 2 Functions	Name of Unit Python Language ogram to explore various data typ nd types. ogram to perform Input and Outp ogram to demonstrate looping i ment.	kages in Python. Hours 8 pes including numer ut Operations. n python and use of 8	CO Targeted CO1 ic types, Boolean f break statement				
Unit Introduction to 1 Introduction to a. Write a Python protection b. Write a Python protection c. Write a Python protection c. Write a Python protection d. Python protection d. Write a Python protection d. Write a Python protection d. Write a Python protection	Name of Unit Python Language ogram to explore various data types. ogram to perform Input and Outprogram to demonstrate looping i ment.	kages in Python. Hours 8 pes including numer ut Operations. n python and use of 8 s	CO Targeted CO1 ic types, Boolean f break statement CO1				
Unit I No. 1 1 Introduction to a. Write a Python pro- types and compour b. Write a Python pro- c. Write a Python pro- and continue stater 2 Functions a. Write a Python pro- b. Write a Python pro- b. Write a Python pro- b.	Name of Unit Name of Unit Python Language Ogram to explore various data types. Ogram to perform Input and Outpogram to demonstrate looping i ment.	kages in Python. Hours B B pes including numer and use of ut Operations. and use of B B S. B Built-in Functions B	CO Targeted CO1 ic types, Boolean f break statement CO1				

3	List, Tuples, Dictionaries and Sets	12	CO1			
a.	Write a Python Program to create list, apply various functions to it.					
b.	b. Write a Python Program to demonstrate concept of aliasing and cloning.					
с.	c. Write a Python Program to implement tuples for storing data. Verify the immutability					
	property on tuples.					
d.	Write a Python Program to implement Dictionary and ope	erations on di	ctionaries.			
e.	Write a Python Program to create sets and various operat	ions on it.				
4	Arrays and String	12	CO2			
a.	Write a Python Program to implement arrays for storing h	omogeneous	data items.			
b.	Apply indexing and slicing operations to access elements	of array.				
с.	Write a Python Program to demonstrate operations and pr	operties of st	ring data types.			
d.	Write a Python Program implement and demonstrate the	e use of Men	nbership operators			
	and Identity operators					
5	Object Oriented Programming	12	CO3			
a.	Write a Python program to define classes and create object	ets.				
b.	Program to implement the inheritance.					
с.	Program to implement the polymorphism.					
			1			
6	Modules and Packages	8	CO4			
a.	Write Python program to import built in and user defined	modules.				
b.	Write Python program to import built in and user defined	packages.				
Re	ference Books					
1.	How to solve it by Computer, R.G. Dromey, Pearson Edu	ucation.				
2.	Mark Lutz, Programming Python, O'Reilly, 4th Edition, 2	2010				
3.	Dive into Python, Mike					
4.	Learning Python, 4th Edition by Mark Lutz					
5.	Programming Python, 4th Edition by Mark Lutz					
6.	Python Programming: An introduction to computer, John Z	Zelle,3rd Edit	ion.			
7.	Data Science Essentials in Python: Collect, Organize, E	xplore, Predi	ct, Value. Dmitry			
	Zinoriev, The Pragmatic Programmers LLC, 2016					
8.	Introduction to Python Programming. Gowrishankar S., V	Veena A. CR	C Press, Taylor &			
	Francis Group, 2019					

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-I

DS103T : Descriptive Statistics

	redits: 02	Teaching Scheme	Examination	n Scheme	
		Theory: 2 Hours/Week	Continuous H	Evaluation:15 Marks	
l		End Semester : 35 Marks			
Prerequi	isites				
• N	Iathematical oper	ations			
Objectiv	es				
• T	o acquaint studen	ts with some basic concepts in	Statistics		
• T	o introduce to som	me elementary statistical metho	ds of analysis of	f data	
• T	o identify the nat	ure and type of data			
• T	o apply statistical	l tools to numerical and categor	cal data		
Course (Dutcomes				
On Comp	pletion of this cou	arse, student will be able to $-$			
CO1: Ide	ntify the differen	t types of variables and data.			
CO2:Cor	npute various me	asures of central tendency, disp	ersion,		
CO3: Co	mpute various me	easures of skewness and kurtosi	s.		
CO4: Fin	d correlation coe	fficient between numerical vari	ables.		
CO5: Fit	linear regression	lines.			
CO6: Fit	non-linear regres	ssion lines.			
Unit			Teach	ing	
Omt		Name of Unit	Itach	mg CO Targeted	
No.		Name of Unit	Hou	rs CO Targeted	
No.	In	Name of Unit troduction to Statistics	Hour 02	rs CO Targeted CO1	
No. 1 Meaning	In of Statistics and	Name of Unit troduction to Statistics l its importance in data science	Hou02e. Concept of p	rs CO Targeted CO Targeted CO1	
No. 1 Meaning Types of	In of Statistics and characteristics (v	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types	e. Concept of p of data (primar	ImageCO TargetedrsCO1oopulation and sample.y and secondary). Raw	
No. 1 Meaning Types of data and	In of Statistics and characteristics (v its classification	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distributes	e. Concept of p of data (primar ution, grouped	ImageCO TargetedrsCO1oopulation and sample.y and secondary). Rawfrequency distribution	
No. 1 Meaning Types of data and and cumu	In of Statistics and characteristics (v its classification alative frequency	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distribution.	e. Concept of primary ution, grouped	ImageCO TargetedrsCO1oopulation and sample.y and secondary). Rawfrequency distribution	
No. 1 Meaning Types of data and and cumu 2	In of Statistics and characteristics (w its classification alative frequency Measures of (Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distribution. Central Tendency and Disper	e. Concept of p of data (primar ution, grouped	CO Targeted construction copulation copulation and secondary). Raw frequency distribution	
No. 1 Meaning Types of data and and cumu 2 Measure	In of Statistics and characteristics (v its classification alative frequency Measures of s of central ter	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distribution. Central Tendency and Disper indency: Concept of central te	Hou02e. Concept of pof data (primar)ution, groupedsion10endency of stat	mig rsCO Targetedcopulation and sample.oopulation and sample.y and secondary). Rawfrequency distributionCO2cistical data. Statistical	
No. 1 Meaning Types of data and and cumu 2 Measure averages:	In of Statistics and characteristics (w its classification alative frequency Measures of (s of central ter Arithmetic measure)	Name of Unit troduction to Statistics lits importance in data science variables and attributes), Types a. Ungrouped frequency distribu- distribution. Central Tendency and Disper- ndency: Concept of central ten n (Definition, effect of change	Hou02e. Concept of pof data (primar)ution, groupedsion10endency of stateof origin and set	mig rsCO TargetedrsCO1oopulation and sample.oopulation and sample.y and secondary). Rawfrequency distributionCO2data. Statisticalcale), Geometric Mean	
No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr	In of Statistics and characteristics (w its classification alative frequency Measures of (s of central ter Arithmetic mean monic Mean, m	Name of Unit troduction to Statistics lits importance in data science variables and attributes), Types a. Ungrouped frequency distribu- distribution. Central Tendency and Disper indency: Concept of central te n (Definition, effect of change redian and mode, partition variables)	House02e. Concept of pof data (primaryution, groupedsion10endency of stateof origin and seulues (Definition)	mig rsCO TargetedrsCO1copulation and sample.y and secondary). Rawfrequency distributionCO2cistical data. Statisticalcale), Geometric Meanons and examples for	
No. No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr ungroupe	In of Statistics and characteristics (w its classification alative frequency Measures of of s of central ter Arithmetic mean monic Mean, m ed and grouped da	Name of Unit troduction to Statistics I its importance in data science variables and attributes), Types I. Ungrouped frequency distribu- distribution. Central Tendency and Disper- ndency: Concept of central ten n (Definition, effect of change redian and mode, partition variata).	Hour02e. Concept of pof data (primar)ution, groupedsion10endency of stateof origin and secondulues (Definition)	CO TargetedrsCO Targetedcopulation and sample.oopulation and sample.y and secondary). Rawfrequency distributionCO2cistical data. Statisticalcale), Geometric Meanons and examples for	
No. No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr ungroupe Situation	In of Statistics and characteristics (w its classification alative frequency Measures of (s of central ter Arithmetic meat monic Mean, m ed and grouped da s where one kind	Name of Unit troduction to Statistics I its importance in data science variables and attributes), Types I. Ungrouped frequency distribu- distribution. Central Tendency and Disper- ndency: Concept of central ten n (Definition, effect of change redian and mode, partition va- ata). of average is preferable to othe	Hou 02 e. Concept of p of data (primar) ution, grouped sion 10 endency of stat of origin and se ulues (Definition	CO Targeted rs CO Targeted content of the secondary CO1 oopulation and sample. y and secondary). Raw generation of the secondary CO2 variable of the secondary CO2 cistical data. Statistical cale), Geometric Mean ons and examples for	
No. No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr ungroupe Situation Measure	In of Statistics and characteristics (w its classification alative frequency Measures of 0 s of central ter Arithmetic meat monic Mean, m ed and grouped da s where one kind s of dispersion:	Name of Unit troduction to Statistics I its importance in data science variables and attributes), Types a. Ungrouped frequency distrib- distribution. Central Tendency and Disper- ndency: Concept of central ten n (Definition, effect of change redian and mode, partition variata). of average is preferable to other concept of dispersion. Range	Hou02e. Concept of pof data (primar)ution, groupedsion10endency of statof origin and sealues (Definitionr.ge, Semi-interque	Images CO Targeted rs CO1 oopulation and sample. co1 oopulation and sample. aw y and secondary). Raw frequency distribution CO2 cistical data. Statistical cale), Geometric Mean ons and examples for uartile range (Quartile citation (citation (citat	
No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr ungroupe Situation Measure deviation	In of Statistics and characteristics (w its classification alative frequency Measures of (s of central ter Arithmetic meat monic Mean, m ed and grouped da s where one kind s of dispersion:): Definition. M	Name of Unit troduction to Statistics I its importance in data science variables and attributes), Types I. Ungrouped frequency distrib- distribution. Central Tendency and Disper- ndency: Concept of central ten (Definition, effect of change redian and mode, partition va- ata). of average is preferable to other Concept of dispersion. Range Mean deviation: Definition, r	Hou 02 e. Concept of p of data (primar) ution, grouped sion 10 endency of stat of origin and se ulues (Definition r. ge, Semi-interque inimality prop	CO Targeted rs CO Targeted content of the secondary CO1 copulation and sample. content of the secondary y and secondary). Raw frequency distribution content of the secondary CO2 cistical data. Statistical cale), Geometric Mean Gons and examples for uartile range (Quartile content of the secondary) perty (without proof), deal	
No. No. 1 Meaning Types of data and and cumu 2 Measure averages: and Harr ungroupe Situation Measure deviation Variance	In of Statistics and characteristics (w its classification alative frequency Measures of (s of central ter Arithmetic meat monic Mean, m ed and grouped da s where one kind s of dispersion:): Definition. M and standard dev	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distribu- distribution. Central Tendency and Disper- ndency: Concept of central tennelite (Concept of Central tennelite) n (Definition, effect of change and mode, partition variation). of average is preferable to other concept of dispersion. Range Mean deviation: Definition, re- viation: Definition, effect of change invitation: Definition, effect of change dispersion. Range Mean deviation: Definition, re- viation: Definition, effect of change dispersion. Range Mean deviation: Definition, re- viation: Definition, effect of change dispersion. Range Mean deviation: Definition, re- viation: Definition, effect of change dispersion. Range Mean deviation: Definition, re- dispersion. Range Mean deviation: Definition. Range M	HouHou02e. Concept of pof data (primar)ution, groupedsion10sion10endency of statof origin and seulues (Definitionr.r.re, Semi-interqueninimality propnge of origin and	CO Targeted rs CO Targeted copulation and sample. oopulation and sample. y and secondary). Raw frequency distribution CO2 cistical data. Statistical cale), Geometric Mean ons and examples for uartile range (Quartile perty (without proof), nd scale. Mean squared	
No. 1 Meaning Types of data and and cumu	In of Statistics and characteristics (v its classification alative frequency Measures of	Name of Unit troduction to Statistics l its importance in data science variables and attributes), Types a. Ungrouped frequency distribution. Central Tendency and Disper	e. Concept of p of data (primar ution, grouped	CO Targeted constraint	

coefficient of mean deviation, coefficient of variation(C.V.).

3	Moments, Skewness and Kurtosis	04	CO3		
Moment	s: Raw moments and Central Moments (Definition for	or for ungrou	iped and grouped		
data). Re	lation between Raw moments and Central Moments (up	to 4 th order w	ithout proof).		
Skewnes	s: Concept of skewness of frequency distribution,	positive sk	ewness, negative		
skewnes	s, symmetric frequency distribution. Bowley's coefficient	ent of skewne	ess(Definition and		
Example	s and Bowley's coefficient of skewness lies between	-1 to 1 (with	nout proof)). Karl		
Pearson'	s coefficient of skewness (Definition and Examples). M	Aeasures of sl	kewness based on		
moments	(Definition and Examples).				
Kurtosis	: Concept of kurtosis, leptokurtic, mesokurtic and plat	ykurtic freque	ency distributions.		
Measure	s of kurtosis based on moments (Definition and Example	es).			
4	Correlation and Regression	10	CO4, CO5		
Correlat	ion: Bivariate data, Scatter diagram and its interpretation	on. Concept of	of Covariance and		
its prope	rties. Correlation between two variables and its types	. Karl Pearso	on's coefficient of		
correlation	on (r) and its computation for ungrouped data. Proper	ties of correla	ation. Spearman's		
rank corr	elation coefficient and its computation.				
Regressi	on: Concept of dependent (response) and indepen	dent (predic	tor or regerssor)		
variables	. Meaning of regression, connection between correlation	n and regressi	ion. Fitting of line		
$Y = \beta_0 + \beta_1 X, \beta_0$ and β_1 are regression coefficients which are estimated using least-square					
method. Properties of regression coefficients. Concept of explained and unexplained variation,					
coefficie	coefficient of determination, standard error of an estimate of line of regression. Concept of				
reverse r	egression.				
5	Non-linear Regression	04	CO6		

Necessity and importance of fitting of non-linear regression. Fitting of second degree $curve(Y = a + bX + cX^2)$, Fitting of exponential curves of the type $Y = ab^x$ and $Y = ax^b$. Fitting of logistic curve.

- 1. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
- 2. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
- 3. Neil, A. Weiss, (2016). Introductory Statistics, Tenth Edition, Pearson.
- 4. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, NewDelhi.
- 5. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentice Hall of India, NewDelhi.
- 6. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. EastWest Press.
- 7. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. 3, McGraw Hill BookCompany.

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-I

DS104P : Lab Course on DS103T (Descriptive Statistics)

No. of (Credits: 02	Teaching Scheme	Examination Scheme		
		Practical: 4 Hours/Week	Continuous Evaluation:1	5 Marks	
	End Semester : 35 Marks				
Prerequ	isites		I		
•]	Mathematical oper	ations			
Objecti	ves				
•	Fo acquaint studen	ts with some basic concepts in	n Statistics		
•	Fo introduce to sor	ne elementary statistical meth	ods of analysis of data		
• 7	To identify the nat	ure and type of data			
•	Γο apply statistical	tools to numerical and catego	rical data		
Course	Outcomes				
On Con	pletion of this cou	rse, student will be able to –			
CO1: Id	entify the different	t types of variables and data.			
CO2:Co	ompute various me	asures of central tendency, dis	persion,		
CO3: C	ompute various me	easures of skewness and kurto	sis.		
CO4: Fi	nd correlation coe	tricient between numerical van	nables.		
CO5: F1	t linear regression	lines.			
CU0: F1	t non-nnear regres	Sion lines.	monta	Hound	
51.110.	List of Practical Assignments			nours	
1	Diagrammatic rej	presentation and interpretation	of statistical data.	4	
2	Graphical represe	entation and interpretation of s	tatistical data	4	
3	Tabulation			4	
	Computation of r	neasures of central tendency f	or grouped and ungrouped	4	
4	data			4	
5	Computation of p	partition values for grouped an	d ungrouped data.	4	
6	Computation of r	neasures of dispersion for gro	uped and ungrouped data	4	
_	Identification the	nature of probability distribut	ion based on measure of	4	
	skewness and kurtosis.				
0	Plotting of Scatte	r diagram and computation of	correlation coefficient	0	
ð	(ungrouped data)			8	
9	Computation of S	Spearman's Rank correlation c	oefficient.	4	
10	Fitting of simple	linear regression model (for b	oth cases Y on X and X on	o	
10	Y).			ð	

11	Fitting of second degree curve.	4
12	Fitting of exponential curve of type $Y = ab^x$, $Y = ax^b$.	8

- 1. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
- 2. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
- 3. Neil, A. Weiss, (2016). Introductory Statistics, Tenth Edition, Pearson.
- 4. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, NewDelhi.
- 5. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentice Hall of India, NewDelhi.
- 6. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. EastWest Press.
- 7. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. 3, McGraw Hill BookCompany.

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-I

DS105T : Computational Mathematics

No. of C	Credits: 2	Teaching Scheme	Examination Scl	neme
		Theory: 2 Hrs/Week	Continuous Evalu	ation:15 Marks
			End Semester: 35	Marks
Prerequ	isites			
•	Basic Mathem	natics Skills		
Objectiv	ves			
 7 7 7 1 7 1 7 1 1<	To understand t leterminants, usin To solving system To understand the inear independen To abstract notion To understand for ransformation, ar Enables to find p	he basic arithmetic operation of technology where appropri- nas of linear equations, using technology of linear e basic terminology of linear ce, spanning, basis, rank, null as of vector space and inner par- find the eigen values and and using them to diagonalize a projections and orthogonality	ons on vectors and ate. echnology to facilitate r ar algebra in Euclidea ity, subspace, and linea coduct space. eigenvectors of a r a matrix.	matrices, including ow reduction. n spaces, including r transformation. matrix or a linear ctors, including the
Course	Outcomes	the normalization process and	l orthogonal matrices.	
On Com	pletion of this co	urse, student will be able to -		
CO1: So	lve systems of lin	near equations using methods	by Gaussian elimination	on.
CO2: De	emonstrate under	standing of the concepts of ve	ctor space, linear indep	bendence and basis.
CO3: De	etermine eigen va	lives and eigenvectors and sol	ve eigenvalue problem	S.
CO4: D	emonstrate unde	erstanding the use of truth	tables and laws of it	ientity, distributive,
	multiply and prov	allon. a Raalaan aynrassians Com	nute sum of products	and product of sum
expansic	mpin'y and prov	e boolean expressions, com	pute sum of products	and product of sum
		Name of Unit	Teaching	CO Targeted
No.			Hours	Co Ingeleu
1	System of Line	ear Equation	6	CO1
Matrices	Determinants.	Cramer's Rule. Echelon for	rm. Row reduction. G	aussian elimination
method.	, Decennicatio,			
2	Vector Spaces		8	CO1. CO2
Introduc	tion to vector s	paces. Some properties of v	ector spaces. Linear of	combination. Linear
independ	lence, Linear de	pendence, Basis and Dimensi	on of a vector space.	Row space, Column
space.	, · · ·]		<u>i</u>	1 '
3	Eigen values a	nd Eigen vectors	8	CO3
Eigen va	lues and Eigen v	ectors, The characteristic equ	ation, Diagonalization.	1

4	Declean function	0	CO4 CO5
4	Boolean function	ð	C04, C05

Relations, Types of Relations, Equivalence relations, Digraphs of relations, Matrix representation and Composition of Relations, Transitive closure and Warshall's Algorithm, Poset, Hasse diagram, Boolean Functions : Introduction, Boolean variable, Boolean Function of degree n, Boolean identities, Definition of Boolean Algebra, Representation of Boolean Functions : Minterm, Maxterm Disjunctive normal form, Conjunctive normal Form.

- 1. Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Ninth Edition, Wiley, 11th edition.
- 2. K. Hoffman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India, New Delhi.
- 3. Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall of India. New Delhi.
- 4. Discrete Mathematical Structures, by Kolman, Busby, Ross, Rehman, Prentice Hall

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-I

DS106P: Lab Course on DS105T (Computational Mathematics)

No. of C	redits: 2	Teaching Scheme	Examination Scheme			
		Practical : 4 Hours/Weel	Continuous Evaluation:15	Marks		
	End Semester: 35 Marks					
Prerequ	isites					
• E	Basic Mathematic	Skills				
Objectiv	/es					
• T d	o understand the eterminants, using	basic arithmetic operation g technology where approp	s on vectors and matrices, including priate.	g		
• 1 • 1 li	o understand the near independence	basic terminology of linea e, spanning, basis.	r algebra in Euclidean spaces, inclu	ıding		
• 1	o abstract notions	s of vector space and inner	product space.			
• T d	o understand find iagonalize a matr	l the eigenvalues and eiger ix.	vectors of a matrix and using then	1 to		
• E	Enables to Simplif roduct of sum exp	y and prove Boolean expro- pansions.	essions. Compute sum of products	and		
• T	o know how to us	se maxima software.				
Course	Outcomes					
On Com	pletion of this cou	urse, student will be able to) -			
CO1: Ur	derstand the system	ems of linear equations us	ing methods by Gaussian elimination	on.		
CO2: De	monstrate unders	tanding of the concepts of	vector space, linear independence	and basis.		
CO3: Co	mpute eigenvalue	es and eigenvectors proble	ms.			
CO4: De	monstrate the use	of truth tables and laws o	f identity, distributive, commutativ	e, and		
dominati	on.					
CO5: Si	mplify and prove	Boolean expressions, Con	pute sum of products and product	of sum		
expansio	ns.					
CO6: Stu	idents can solve t	he problem based on theor	y by using maxima software.			
Sr.No.		List of Practical A	ssignments	Hours		
1	Problem Solving	g on Unit 1: System of Li	near Equation (Written)	4		
2	Problem Solving	g on Unit 2: Vector Space	s (Written)	8		
3	Problem Solving	g on Unit 3: Eigen values	and Eigen vectors (Written)	8		
4	Problem Solving	g on Unit 4: Boolean fun	ction (Written)	8		
5	Problem Solving Software)	g on Unit 1: System of Lin	near Equation (Using Maxima	8		
6	Problem Solving	g on Unit 2: Vector Space	s (Using Maxima Software)	8		
7	Problem Solving Maxima Softwa	g on Unit 3: Eigen values re)	and Eigen vectors (Using	8		

	8	Problem Solving on Unit 4: Boolean function (Using Maxima Software)	8
Re	feren	ce Books	
1.	How	ard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Nin	th
	Editi	on, Wiley, 11th edition.	
2.	К. Н	offman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India	a, New
	Delh	i.	
3.	Steve	en J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall of	of India.
	New	Delhi.	
4.	Discr	rete Mathematical Structures, by Kolman, Busby, Ross, Rehman, Prentice Hall	

Savitribai Phule Pune University **B.Sc. Data Science (Pattern 2024)** Semester-I

SEC101DS: Computer Organization

No	of Cradits.	Topphing Schomo	Examinat	ion Scheme		
110.	γ	Theory: 2 Hours/Week	Continuou	s Evaluation	:15 Marks	
	Z	Theory. 2 Hours/ week	End Semes	ster :35 Mark	CS	
Prerequisites						
• 1	Number systems ar	nd basics of digital electronics.				
Objectiv	ves					
• 7	• To revise about different number systems, codes, logic gates with truth tables.					
• 7	o understand com	binational and sequential circu	its of digital	electronics.		
• 7	To conceptualize th	ne basics of organizational and	architectura	l issues of a	digital computer	
a	nd learn about var	ious data transfer techniques ir	n digital com	puter and the	e I/O interfaces.	
• 7	To know how I/O a	devices are accessed and its pri	nciples and	to provide th	e knowledge on	
Ι	nstruction Level P	arallelism.				
• 7	To study architect	ure				
Course	Outcomes					
On Com	pletion of this cou	rse, student will be able to -				
CO1: U	nderstand number	systems related to computer an	nd their inter	-conversion.		
CO2: Fa	miliar with digital	l circuits, their types, and appli	cations.			
CO3: U	nderstand CPU and	d Memory organizations for the	e fundament	als of compu	iter.	
CO4: St	udy interfacing of	peripherals with CPU in serial	and parallel	l manner with	h data	
converto	ors.					
CO5:Stu	udy basics of micro	oprocessor architecture and con	ncept of pipe	elining		
Unit		Name of Unit		Teaching	CO Targeted	
No.		Name of Omt		Hours	eo largella	
1	Digital Circuits			12	CO1, CO2	
Number	Systems: Binary,	Hexadecimal, BCD and their	inter-conve	ersion. Gray	code and ASCII	
code. Lo	gic Gates: Basic g	gates, derived gates, positive a	nd negative	logic, Simpl	ification of logic	
circuits,	De-Morgan's theo	orem. Concept of K map and si	mplification	of single exp	pressions (upto 4	
variables	s). Combinational	circuits: Half adder, full adder	er, half Subt	ractor, Multi	plexer (2:1 and	
4:1), De	multiplexer (1:2 a	nd 1:4) using basic gates, Enco	oder - Decin	nal to BCD,	Decoder - 3 to 8	
decoder.	Sequential circu	its: Concept of triggering, F	Flip-Flops: S	SR, JK, D	and T.Counters:	
Synchronous and Asynchronous (3-bit), Shift registers: types and applications.						
2	CPU, Memory a	and I/O Organizations		12	CO3, CO4	
CPU O	rganization: Fun	ctions of CPU, General regis	sters used i	n CPU: PC,	SP, instruction	
pointer,	instruction registe	r, instruction decoder, flag, ge	neral purpo	se registers,	memory address	
register,	memory byte regi	ster, General register organizat	ion of CPU,	Concept of	stack.	
Memory	v organization: N	Iemory hierarchy, cache memo	ory and its a	ddress mapp	oing, Associative	
memory	Virtual momory	N (1 1				
memory	, viituai memory,	Memory management through	segmentatio	on and paging	g.	

I/O Organization: Block diagram of parallel interface and function of blocks, Concept of interrupt, IVT, Types of I/O transfer, CPU initiated, interrupt initiated, DMA (only concept),Data convertors:R-2RDAC, ADC (flash, successive approximation), Serial communication and types.

3	Architecture of Microprocessor and Parallel Processing	6	CO5

Architecture of Microprocessor: Block diagram of 8086 and function of blocks, 8086 Registers, Numeric co-processor - concept, block diagram and functions of blocks.

Parallel Processing: Concept of parallelism, Parallel computer structures. Concept of pipelining, Pipelined computers, Instruction pipeline, Arithmetic pipeline, Concept of RISC and CISC. RISC pipelining.

- 1. Modern Digital Electronics, 4thedition, R P Jain, Tata McGraw Hill publication.
- 2. Digital Logic & Computer Design, Morris Mano, Pearson.
- 3. Computer Systems Architecture Moris Mano, 3rdEdition, Pearson
- 4. Computer Systems Organization & Architecture- John D. Carinelli Pearson publication.

Savitribai Phule PuneUniversity B.Sc. Data Science (Pattern 2024) Semester-II

DS151T : Advanced Python Programming

No. of C	redits: 2	Teaching Scheme	Examination Sch	eme	
		Theory:2 Hrs /Week	Continuous Evalua	ation:15 Marks	
			End Semester:35 N	Marks	
Prerequ	isites				
• Fundamentals of Python Programming Language.					
• Prior knowledge of computational mathematics.					
Objectiv	ves				
• T	o learn reading, v	vriting and manipulating files			
• Т	o implement lib	raries like Pandas, NumPy,Sci	Py, Matplotlib, Sc	cikit-learn etc. in	
P	ython.	-	-		
• T	o implement the	concepts of GUI controls and des	signing GUI applica	tions.	
•	Fo learn and know	v the concepts of file handling, ex	ception handling.		
Course	Outcomes				
On Com	pletion of this cor	urse student will be able to -			
CO1: Le	earn reading and v	vriting into files using Python			
CO2: D	esign and implement	ent a program to solve a computa	tional problem.		
CO3: U	nderstand implem	nentation of libraries like Pandas	s, NumPy, SciPy, N	Matplotlib, Scikit-	
learn etc	. in Python.		, , , , , , , , , , , , , , , , , , , ,	1 /	
СО4: Не	ow to handle exce	ptions and files.			
CO5 : Design and implement GUI application					
CO5: De	esign and impleme	ent GUI application			
CO5: De Unit	esign and impleme	ent GUI application Name of Unit	Teaching	CO Targeted	
CO5: De Unit No.	esign and impleme	ent GUI application Name of Unit	Teaching Hours	CO Targeted	
CO5: De Unit No. 1	esign and impleme File Handling	ent GUI application Name of Unit	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1.1 Intro	esign and impleme File Handling duction to Files	ent GUI application Name of Unit	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type	esign and impleme File Handling duction to Files es of Files	ent GUI application Name of Unit	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper	File Handling duction to Files es of Files ning and Closing a	n Text File	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi	File Handling duction to Files es of Files ing and Closing a ing to a Text File	n Text File	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writh 1.5 Read	File Handling Guction to Files duction to Files es of Files hing and Closing a ing to a Text File ing from a Text F	n Text File	Teaching Hours3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin	File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil	a Text File	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin 1.7 Crea	File Handling File Handling duction to Files es of Files hing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir	a Text File rile e a Text File	Teaching Hours 3	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writh 1.5 Read 1.6 Settin 1.7 Creat	File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari	ant GUI application Name of Unit Text File Pile e ng a Text File es	Teaching Hours317	CO Targeted CO1 CO2 & CO3	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writh 1.5 Read 1.6 Settin 1.7 Crea 2 2.1 Intro	File Handling File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari oduction to Pytho	n Text File a Text File a Text File a Text File b a Text File a Text File a Text File b a Text File	Teaching Hours317	CO Targeted CO1 CO2 & CO3	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin 1.7 Crea 2 2.1 Intro 2.1.1 Sta	File Handling File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari oduction to Pytho tistical Analysis-	n Text File is a Text File i	Teaching Hours 3	CO Targeted CO1 CO2 & CO3	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin 1.7 Crea 2 2.1 Intro 2.1.1 Sta 2.1.2 Da	File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari oduction to Python tistical Analysis- ta Visualization-1	n Text File is a Text File i	Teaching Hours 3 17 dels	CO Targeted CO1	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin 1.7 Crea 2 2.1 Intro 2.1.1 Sta 2.1.2 Da 2.1.3 Da	File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari oduction to Pytho tistical Analysis- ta Visualization- I ta Modelling and	n Text File rile e ng a Text File s es on Libraries NumPy, SciPy, Pandas, StatsMo Matplotlib, Seaborn, Plotly Machine Learning- Scikit-learn,	Teaching Hours 3	CO Targeted CO1 CO2 & CO3	
CO5: De Unit No. 1 1.1 Intro 1.2 Type 1.3 Oper 1.4 Writi 1.5 Read 1.6 Settin 1.7 Crea 2 2.1 Intro 2.1.1 Sta 2.1.2 Da 2.1.3 Da 2.1.4 De	File Handling duction to Files es of Files ing and Closing a ing to a Text File ing from a Text F ng Offsets in a Fil ting and Traversir Python Librari oduction to Pythe tistical Analysis- ta Visualization- I ta Modelling and ep Learning- Tens	A Text File a Text File a Text File a Text File b a Text File a Text File e s on Libraries NumPy, SciPy, Pandas, StatsMo Matplotlib, Seaborn, Plotly Machine Learning- Scikit-learn, sorFlow, Pytorch, Keras	Teaching Hours 3 17 dels XGBoost, Eli5	CO Targeted CO1	

2.2 Working with Tabular Numeric Data(Numpy with Python)

2.2.1 NumPy Arrays Creation Using array() Function

2.2.2 Array Attributes, NumPy Arrays Creation with Initial Placeholder Content

2.2.3 Integer Indexing, Array Indexing, Boolean ArrayIndexing, Slicing and Iterating in Arrays

Basic Arithmetic Operations on NumPy Arrays

2.2.4 Mathematical Functions in NumPy

2.2.5 Changing the Shape of an Array, Stacking and Splitting of Arrays, Broadcasting in Arrays.

2.3 Working with Data Series and Frames

2.3.1 Pandas Data Structures, Reshaping Data, Handling Missing Data

2.3.2 Combining Data, Ordering and Describing Data, Transforming Data, Taming Pandas File I/O

2.4 Plotting

Basic Plotting with PyPlot, Matplotlib, Getting to Know Other Plot Types, Plotting with Pandas

3	Exception Handling	5	CO4
3.1 Pythe	on Exception		
3.2 Com	mon Exception		
3.3 Exce	ption handling in Python (try-except-else)		
3.4 The 6	except statement with no exception		
3.5 Mult	iple Exception		
3.6 The t	ry-finally clause		
3.7 Custo	om Exception and assert statement		
4	GUI Programming	5	CO5
4.1 Intro	duction		
4.2 Tkint	er programming		
4.3 Tkint	er widgets		
4.5 Fram	e		
4.6 Butto	on		
4.7 Labe	1		
4.8 Entry	7		
Referen	ce Books		
1.Mark I	Lutz, Programming Python, O'Reilly, 4th Edition, 2010		
2.Dive in	to Python, Mike		
3. Learni	ng Python, 4th Edition by Mark Lutz		
4. Progra	mming Python, 4th Edition by Mark Lutz		
5.Python	Programming: An introduction to computer, John Zelle, 3	rd Edition.	
6. Data	Science Essentials in Python: Collect, Organize, Ex	plore, Predic	t, Value. Dmitry
Zinoriev	, The Pragmatic Programmers LLC, 2016		
7. Introd	luction to Python Programming. Gowrishankar S., Ve	ena A. CRC	Press, Taylor &

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-II

DS152P : Lab Course on DS151T (Advanced Python Programming)

No. of C	redits: 2	Teaching Scheme	Examination Sch	eme			
		Practical: 4 Hrs/Week	Continuous Evalua	ation: 15 Marks			
			End Semester:	35 Marks			
Prerequ	isites						
• P	ractical Knowled	ge of Python Programming.					
• P	rior knowledge of	f computational mathematics.					
Objectiv	Objectives						
• T	• To learn reading, writing and manipulating files						
• T	o implement lib	raries like Pandas, NumPy,Sci	Py, Matplotlib, Sc	ikit-learn etc. in			
Р	ython.			, •			
• 1	o implement the	concepts of GUI controls and des	signing GUI applicat	tions.			
Course	Outcomes	the concepts of the handling, es	ception nandring.				
On Com	pletion of this cor	urse, student will be able to -					
CO1: Le	earn reading and v	vriting into files using Python					
CO2: De	esign and implement	ent a program to solve a computa	tional problem.				
CO3: U	nderstand implem	nentation of libraries like Pandas	s, NumPy, SciPy, N	Aatplotlib, Scikit-			
learn etc	in Python.		, , , , ,	1 /			
СО4: Но	ow to handle exce	ptions and files.					
CO5: De	esign and impleme	ent GUI application					
Unit		Name of Unit	Hours	CO Targeted			
No.							
1	File Handling		8	CO1			
a. A	ssignments on re	ading and writing files					
b. A	ssignments on ac	cessing and manipulating files					
2	Python Numpy		12	CO2			
a. A	ssignments on N	umpy basics.					
b. A	ssignments on N	umpy Arrays.					
c. A	ssignments on N	umpy Linear Algebra					
d. A	ssignments on N	umpy Statistics					
e. A	ssignments on N	umpy Strings					
3	Python Pandas		8	CO3			
a	. Assignments of	n reading and writing text, CSV	files using Pandas				
4	Plotting in Pyth	ion		CO3			
a	. Assignments of	n plotting graphs in python using	Matplotlib and Pyp	lot			
5	Assignments or	Exception Handling	8	CO4			
6	Assignments or	a GUI	12	CO5			

Reference Books

1.Mark Lutz, Programming Python, O'Reilly, 4th Edition, 2010

2. Dive into Python, Mike

3. Learning Python, 4th Edition by Mark Lutz

4. Programming Python, 4th Edition by Mark Lutz

5.Python Programming: An introduction to computer, John Zelle, 3rd Edition.

6. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016

7. Introduction to Python Programming. Gowrishankar S., Veena A. CRC Press, Taylor & Francis Group, 2019

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DS153T : Discrete Probability and Probability Distributions

No. of Credits: 02	Teaching Scheme	Examination Sch	eme				
	Theory: 2 Hours/Week	Continuous Evalu	ation:15 Marks				
		End Semester : 35	Marks				
Prereguisites							
 Basics of Set th 	eory Mathematical operations						
Chiactives							
• To revise the ba	asic concepts of probability axiomat	tic theory of probab	ility				
 To revise the bit To understand t 	the concept of random variable	the theory of probab	inty.				
 To understand t To study probal 	bility distribution (univariate and biv	variate) discrete ran	dom variables				
expectation and	moments of probability distribution	n	dom variables,				
 To find marging 	al distribution and conditional distrib	bution of bivariate f	requency				
distribution			requeriey				
 To find condition 	onal mean of bivariate frequency dis	tribution					
 To find variance 	e covariance and correlation of biva	ariate frequency dist	ribution				
Course Outcomes		anate nequency and					
On Completion of this	course student will be able to –						
CO1: Find the probabil	lities of events and its expectation in	nean variance etc.					
CO2:Distinguish betwe	een random and non-random experir	nents					
CO3:Identify the natur	e of distribution						
CO4: Find marginal dis	stribution and conditional distribution	n	CO4. Find managinal distribution and conditional distribution				
CO4: Find marginal distribution and conditional distribution							
CO5: Find mean of ma	rginal distribution and conditional n	nean of bivariate fre	equency				
CO5: Find mean of ma distribution	rginal distribution and conditional n	nean of bivariate fre	equency				
CO5: Find mean of ma distribution CO6: Find correlation	rginal distribution and conditional n of bivariate frequency distribution	nean of bivariate fre	equency				
CO5: Find mean of ma distribution CO6: Find correlation Unit	of bivariate frequency distribution	nean of bivariate fre	equency				
CO5: Find mean of ma distribution CO6: Find correlation Unit No.	of bivariate frequency distribution Name of Unit	nean of bivariate fre Teaching Hours	equency CO Targeted				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1	of bivariate frequency distribution Name of Unit	mean of bivariate fre Teaching Hours 07	co Targeted				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability	of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of	nean of bivariate fre Teaching Hours 07 deterministic and	co Targeted CO1, CO2 non-deterministic				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment.	Teaching Hours 07 deterministic and	cO Targeted CO1, CO2 non-deterministic				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample	of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin	Teaching Hours 07 deterministic and nite and countably	cO Targeted CO 1, CO2 non-deterministic				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event,	Teaching Hours 07 deterministic and nite and countably Impossible event.	co Targeted CO1, CO2 non-deterministic y infinite, Event,				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event	of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an	Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra o	equency CO Targeted CO1, CO2 non-deterministic y infinite, Event, of events and its				
CO5: Find mean of ma distribution CO6: Find correlation of Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event representation in set the	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an eory notation. Occurrence of follows	Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra o ing events (i) at leas	cO Targeted CO1, CO2 non-deterministic infinite, Event, of events and its st one of the given				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event representation in set the events, (ii) none of the	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an eory notation. Occurrence of follows given events, (iii) all of the given e	Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra o ing events (i) at leas vents, (iv) mutually	cO Targeted CO1, CO2 non-deterministic y infinite, Event, of events and its st one of the given exclusive events,				
CO5: Find mean of ma distribution CO6: Find correlation of Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event representation in set the events, (ii) none of the (v) mutually exhaustive	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an eory notation. Occurrence of follows given events, (iii) all of the given e e events, (vi) exactly one event out of	Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra of ing events (i) at leas vents, (iv) mutually of the given events.	cO Targeted CO1, CO2 non-deterministic infinite, Event, of events and its st one of the given exclusive events,				
CO5: Find mean of ma distribution CO6: Find correlation Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event representation in set the events, (ii) none of the (v) mutually exhaustive Classical definition of	rginal distribution and conditional n of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an eory notation. Occurrence of follow given events, (iii) all of the given e e events, (vi) exactly one event out of probability and its limitations. Proba	Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra o ing events (i) at leas vents, (iv) mutually of the given events. ability model, proba	CO Targeted CO1, CO2 non-deterministic y infinite, Event, of events and its st one of the given exclusive events, ubility of an event,				
CO5: Find mean of ma distribution CO6: Find correlation of Unit No. 1 Basics of Probability models. Random Exper Definitions: Sample Elementary event, Con Occurrence of event representation in set the events, (ii) none of the (v) mutually exhaustive Classical definition of equiprobable and non-e	of bivariate frequency distribution Name of Unit Introduction to Probability y: Experiments/Models, Ideas of riment. space, Discrete sample space: fin nplement of an event, Certain event, ts: Concept of occurrence of an eory notation. Occurrence of following given events, (iii) all of the given e e events, (vi) exactly one event out of probability and its limitations. Proba- equiprobable sample space.	Teaching Teaching Hours 07 deterministic and nite and countably Impossible event. event. Algebra or ing events (i) at lease vents, (iv) mutually of the given events. ability model, proba	CO Targeted CO1, CO2 non-deterministic y infinite, Event, of events and its st one of the given r exclusive events, ability of an event,				

axiomatic definition such as $P(AUB) = P(A) + P(B) - P(A \cap B)$. Generalization $P(AUBUC), 0 \le P(A) \le 1, P(A) + P(A') = 1, P(\Phi) = 0$ and when $A \subseteq B$ then $P(A) \le 1$

2Conditional Probability05CO2Definition of conditional probability of an event. Results on conditional probability. Definitionof independence and mutualindependence for three events. Multiplication theorem $P(A \cap B) = P(A) P(B A)$.Generalization to $P(A \cap B \cap C)$. Partition of the samplespace, prior and posteriorprobabilities.Proof of Bayes' theorem. Applications of Bayes' theorem in reallife.3Univariate Probability Distributions and its9CO3Univariate Probability Distributions defined on Discrete Sample Space: Concept anddefinition of a discrete random variable. Probability Mass Function (mff) and cumulativeDistribution Function (cdf), $F(\cdot)$ of discrete random variable, properties of cdf. Mode andmedian of a univariate discrete probability distribution.Mathematical Expectation: Definition of expectation (mean) of a random variable,expectation of a function of a random variable. Moment Generating Function (mgf) andCumulative Generating Function (cgf). Properties of mgf andcgf.Definition of raw, central and factorial raw moments of univariate probability Distributions andtheir interelations (without proof). Coefficients of skewness and kurtosis based on moments.4Mathematical Expectation for Bivariate Frequency Distribution9CO4, CO5, CO60Edinition of raw and central moments. mgf and cgf. Theorems on expectation. Definition of conditional mean and conditional variables. Conditional expectation. Definition of conditional discrete random variables.4Mathematical Expectation for Bivariate Frequency Distribution9CO4, CO5, CO6 <th>P(B).</th> <th></th> <th></th> <th></th>	P(B).			
Definition of conditional probability of an event. Results on conditional probability. Definitionof independence of two events $P(A \cap B) = P(A)P(B)$. Pairwise independence and mutualindependence for three events. Multiplication theorem $P(A \cap B) = P(A)P(B A)$.Generalization to $P(A \cap B \cap C)$. Partition of the samplespace, prior and posteriorprobabilities.Proof of Bayes' theorem. Applications of Bayes' theorem in reallife.3Univariate Probability Distributions and its9CO3Univariate Probability Distributions defined on Discrete Sample Space: Concept anddefinition of a discrete random variable. Probability Mass Function (mf) and cumulativeDistribution Function (cd) , $F(\cdot)$ of discrete random variable, properties of cdf . Mode andmedian of a univariate discrete probability distribution.Mathematical Expectation: Definition of expectation (mean) of a random variable,expectation of a function of a random variable. Moment Generating Function (mgf) andCumulative Generating Function (cgf) . Properties of mgf and cgf .Definition of raw, central and factorial raw moments of univariate probability Distributions and their interrelations (without proof). Coefficient of skewness and kurtosis based on moments.4Mathematical Expectation for Bivariate Prequency Distribution0function and contribution of covariance, cofficient of correlation, independence and uncorrelatedness of two variables. Variance of linear combination of variables, $Var(aX + bY)$. $Var(aX + bY + C)$ and its generalization.8Reference Books1.Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Editio	2	Conditional Probability	05	CO2
of independence of two events $P(A \cap B) = P(A)P(B)$. Pairwise independence and mutual independence for three events. Multiplication theorem $P(A \cap B) = P(A)P(B A)$. Generalization to $P(A \cap B \cap C)$. Partition of the samplespace, prior and posterior probabilities.Proof of Bayes' theorem. Applications of Bayes' theorem in reallife.3Univariate Probability Distributions and its Mathematical Expectation9CO3Univariate Probability Distributions defined on Discrete Sample Space: Concept and definition of a discrete random variable. Probability Mass Function (pmf) and cumulative Distribution Function (cdf) , $F(\cdot)$ of discrete random variable, properties of cdf . Mode and median of a univariate discrete probability distribution.Mathematical Expectation: Definition of expectation (mean) of a random variable, expectation of a function of a random variable. Moment Generating Function (mgf) and Cumulative Generating Function (cgf) . Properties of mgf and cgf .Definitions of variance, standard deviation (SD) and Coefficient of variation (CV) of univariate probability distribution, effect of change of origin and scale on mean, variance and SD. Definition of raw, central and factorial raw moments of univariate probability Distributions and their interrelations (without proof). Coefficients of skewness and kurtosis based on moments.4Mathematical Expectation for Bivariate Frequency Distribution9CO4, CO5, CO60Efinition of raw and central moments, mgf and cgf . Theorems on expectation. Definitions of conditional wariables. Variance of linear combination of variables, $Var(aX + bY)$, $Var(aX + bY + C)$ and its generalization.4Mathematical Expectation to Mathematical Statistics, Eighth Edition of sub and condinal variables. New De	Definition	on of conditional probability of an event. Results on cor	ditional prob	ability. Definition
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SavitribaiPhule Pune University B.Sc. Data Science (Pattern 2024) Semester-II

DS154P : Lab Course on DS153T (Discrete Probability and Probability Distributions)

Practical: 4 Hours/Week Continuous Evaluation: 15 Marks End Semester : 35 Marks Prerequisites • Basics of Set theory, Mathematical operations Objectives • To understand the concept of random variable • To study probability distribution (univariate and bivariate) discrete random variables, expectation and moments of probability distribution • To find marginal distribution and conditional distribution • To find conditional mean of bivariate frequency distribution • To find conditional mean of bivariate frequency distribution • To find variance, covariance and correlation of bivariate frequency distribution • To find variance, covariance and correlation of bivariate frequency distribution • To find variance, covariance and correlation of bivariate frequency distribution • Course Outcomes On Completion of this course, student will be able to – CO1: Find the probabilities of events and its expectation, mean, variance, etc. CO2: Distinguish between random and non-random experiments CO3: Identify the nature of distribution CO4: Find mean of marginal distribution and conditional mean of bivariate frequency distribution CO5: Find correlation of bivariate frequency distribution CO6: Find correlation of probability for different events based on real life 1 Calcu	No. of C	Credits: 02	Teaching Scheme	Examination Scheme	<u>,</u>
Interfact of the second secon	1100 01 0		Practical: 4 Hours/Week	Continuous Evaluation	n:15 Marks
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distribution• To find conditional mean of bivariate frequency distribution• To find variance, covariance and correlation of bivariate frequency distributionCourse OutcomesOn Completion of this course, student will be able to – CO1: Find the probabilities of events and its expectation, mean, variance, etc. CO2:Distinguish between random and non-random experiments CO3:Identify the nature of distribution CO4: Find marginal distribution and conditional distribution CO5: Find mean of marginal distribution and conditional mean of bivariate frequency distribution CO6: Find correlation of bivariate frequency distributionSr.No.List of Practical Assignments1Calculation of probability for different events based on real life situations.2Calculation of mathematical expectation and variance.3Obtain marginal and conditional distribution of bivariate probability distribution4Calculation of conditional expectation and conditional variance4Calculation of variance of linear combination.4Calculation of the correlation coefficient based on bivariate probability distribution4Calculation of the correlation coefficient based on bivariate probability distribution4Calculation of the correlation coefficient based on bivariate probability distribution4Saluation of the correlation coefficient based on bivariate probability distribution4Saluation of the correlation coefficient based on bivariate probability distribution4Saluation of the correlation coefficient based on bivariate probability distribution7	• 7	To find marginal d	istribution and conditional distri	bution of bivariate frequ	iency
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 To find variance, covariance and correlation of bivariate frequency distribution Course Uutcomes On Completion of this course, student will be able to – CO1: Find the probabilities of events and its expectation, mean, variance, etc. CO2:Distinguish between random and non-random experiments CO3:Identify the nature of distribution CO4: Find marginal distribution and conditional distribution CO5: Find mean of marginal distribution and conditional mean of bivariate frequency distribution CO5: Find mean of bivariate frequency distribution CO6: Find correlation of bivariate frequency distribution CO6: Find correlation of probability for different events based on real life situations. A calculation of mathematical expectation and variance. 4 4 Calculation of conditional distribution of bivariate probability distribution 4 4 Calculation of variance of linear combination. 4 4 6 Calculation of the correlation coefficient based on bivariate probability distribution 4 6 7 Calculation of conditional expectation and variance. 4 6 7 Calculation of the correlation coefficient based on bivariate probability distribution 4 8 8 Model sampling from the given probability distributions 12 9 Small Project equivalent to 4 practical. 16	• 7	To find conditional	l mean of bivariate frequency di	stribution	
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CO4: Find marginal distribution and conditional distributionCO5: Find mean of marginal distribution and conditional mean of bivariate frequencydistributionCO6: Find correlation of bivariate frequency distributionSr.No.HoursCalculation of probability for different events based on real life situations.4Obtain marginal and conditional distribution of bivariate probability distribution4Calculation of mathematical expectation and variance.4Calculation of conditional expectation and conditional variance4Calculation of the correlation coefficient based on bivariate probability distribution4Calculation of the correlation coefficient based on bivariate probability distribution4Calculation of the correlation coefficient based on bivariate probability distribution4Calculation of the correlation coefficient based on bivariate probability distribution4 <th< td=""><td>CO3:Ide</td><td>ntify the nature of</td><th>distribution</th><td></td><td></td></th<>	CO3:Ide	ntify the nature of	distribution		
CO5: Find mean of marginal distribution and conditional mean of bivariate frequency distributionCO6: Find correlation of bivariate frequency distributionSr.No.Hours 2 Calculation of probability for different events based on real life situations.42Calculation of mathematical expectation and variance.43Obtain marginal and conditional distribution of bivariate probability distribution44Calculation of conditional expectation and variance.44Calculation of conditional expectation and conditional variance44Calculation of conditional expectation and conditional variance44Calculation of conditional expectation and conditional variance45Calculation of variance of linear combination.46Checking the independence of the probabilities of the events46Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	CO4: Fit	nd marginal distrik	oution and conditional distributi	on	
distributionCO6: Find correlation of bivariate frequency distributionSr.No.List of Practical AssignmentsHours1Calculation of probability for different events based on real life situations.42Calculation of mathematical expectation and variance.43Obtain marginal and conditional distribution of bivariate probability distribution44Calculation of conditional expectation and conditional variance45Calculation of variance of linear combination.46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	CO5: Fi	nd mean of margir	nal distribution and conditional i	nean of bivariate freque	ncy
CO6: Find correlation of bivariate frequency distributionHoursSr.No.List of Practical AssignmentsHours1Calculation of probability for different events based on real life situations.42Calculation of mathematical expectation and variance.43Obtain marginal and conditional distribution of bivariate probability distribution44Calculation of conditional expectation and conditional variance45Calculation of conditional expectation and conditional variance46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	distribut	ion			
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2Calculation of mathematical expectation and variance.43Obtain marginal and conditional distribution of bivariate probability distribution44Calculation of conditional expectation and conditional variance45Calculation of variance of linear combination.46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16		situations.			
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distributiondistribution4Calculation of conditional expectation and conditional variance45Calculation of variance of linear combination.46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	3	Obtain marginal	and conditional distribution of l	pivariate probability	4
4Calculation of conditional expectation and conditional variance45Calculation of variance of linear combination.46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16		distribution			
5Calculation of variance of linear combination.46Checking the independence of the probabilities of the events47Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	4	Calculation of co	onditional expectation and condi	tional variance	4
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7Calculation of the correlation coefficient based on bivariate probability distribution88Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	6	Checking the ind	lependence of the probabilities of	of the events	4
distribution128Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16	7	Calculation of th	e correlation coefficient based of	on bivariate probability	8
8Model sampling from the given probability distributions129Small Project equivalent to 4 practical.16		distribution			
9 Small Project equivalent to 4 practical. 16	8	Model sampling	trom the given probability distr	ibutions	12
	9	Small Project eq	uivalent to 4 practical.		16

- 1. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
- 2. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, New Delhi.
- 3. Hoel, P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
- 4. Hogg,R.V.and Craig, R.G.(1989).Introduction to Mathematical Statistics,Ed. MacMillan Publishing Co., New York.
- 5. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.
- 6. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. 3, McGraw Hill Book Company.
- 7. Rao, VLS Prakash (2008). First Course in Probability and Statistics, New Age International Publishers, New Delhi.
- 8. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. & Dorling Kindersley Publishing,Inc.

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-II

DS155T : Graph Theory

No of C	moditor ?	Toophing Schome	Evamination	Sahama		
110. 01 C	reuns. 2	Theory 2 Hrs/Week	Continuous Ex	valuation.	15 Marks	
		111001 <i>y</i> . 2 1110/ (COR	End Semester	:	35 Marks	
Prerequ	isites		L			
Basics of mathematics, Set Theory						
Objectiv	/es					
• T	o introduce s	tudents about graph, grap	ph models, ty	pes of gra	ph, connectivity,	
aj	oplications of g	raph theory.				
• T	o know how to	find shortest path for differ	ent Eulerian and	d Hamiltoni	an circuit.	
• T	o introduce stu	udents about Trees, application	ations of trees,	, binary tre	e, tree traversal,	
sı	panning trees.					
• T	o know how to	find minimum spanning tre	es.			
• T	o make student	s familiar with the use of al	l these concepts	s as tools in	other areas of the	
С	ourse curricului	m.				
Course	Outcomes					
On Com	pletion of this c	course, student will be able	to:			
CO1: U	nderstand the g	raph, and graph models, ter	minology of gra	aph.		
CO2: St	udents can solv	e examples on adjacency ar	nd incidence ma	atrix.		
CO3: Id	entify the Euler	tours and Hamiltonian cyc	le and find shor	rtest path.		
CO4: A	ble to Compute	the shortest spanning trees.				
CO5: St	udents can solv	the problems on tournan	nents and traffic	c flow.		
Unit Name of Unit Teaching CO Targeted						
Unit		Name of Unit		Teaching	CO Targeted	
No.		Name of Unit		Teaching Hours	CO Targeted	
No.	Graphs and	Name of Unit Graph Models		Teaching Hours 4	CO Targeted CO1, CO5	
No. 1 Graph: I	Graphs and Operation of Graphs	Name of Unit Graph Models c terminology of Graph, Gra	ph Models, Soo	Teaching Hours 4 cial network	CO Targeted CO1, CO5	
No. 1 Graph: I Commun	Graphs and Operation of the second se	Name of Unit Graph Models c terminology of Graph, Gra ks, Information networks ,	ph Models, Soc Software Design	Teaching Hours 4 cial network n Applicatio	CO Targeted CO1, CO5	
No. 1 Graph: I Commun Transpor	Graphs and Definition, basic nication networ tation network	Name of Unit Graph Models c terminology of Graph, Gra ks, Information networks , cs, Biological networks, Tou	aph Models, Soo Software Design Irnaments.	Teaching Hours 4 cial network n Applicatio	CO Targeted CO1, CO5	
No. 1 Graph: I Commun Transpor 2	Graphs and Operation of the second se	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks , as, Biological networks, Tou orphism	oph Models, Soo Software Design Irnaments.	Teaching Hours 4 cial network n Applicatio	CO Targeted CO1, CO5 cs, ons, CO2	
No. 1 Graph: I Commun Transpor 2 Handsha	Graphs and Operation, basic nication network tation network Graph Isomo king lemma, Sp	Name of Unit Graph Models c terminology of Graph, Gra ks, Information networks , cs, Biological networks, Tou orphism pecial Types of Graph, Dire	aph Models, Soo Software Design Irnaments.	Teaching Hours 4 cial network n Applicatio 5 trix represen	CO Targeted CO1, CO5 cs, ons, CO2 ntation of graph,	
No. 1 Graph: I Commun Transpor 2 Handsha Definitio	Graphs and O Definition, basic nication network tation network Graph Isomo king lemma, Spon of isomorphi	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S s, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi	aph Models, Soc Software Design Irnaments. cted graph, Mat sm of graphs.	Teaching Hours 4 cial network n Applicatio 5 trix represen	CO Targeted CO1, CO5 cs, ons, CO2 ntation of graph,	
No. 1 Graph: I Commun Transpon 2 Handsha Definitio 3	Graphs and O Definition, basic nication network tation network Graph Isomo king lemma, Sp on of isomorphi Connected G	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S s, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi raph	aph Models, Soc Software Design Irnaments. cted graph, Mat sm of graphs.	Teaching Hours 4 cial network n Applicatio 5 trix represen 8	CO Targeted CO1, CO5 as, ons, CO2 ntation of graph, CO3	
No. 1 Graph: I Commun Transpon 2 Handsha Definitio 3 Walk, tra	Graphs and Operation, basic nication network tation network Graph Isomo king lemma, Spon of isomorphi Connected G ail, path, cycle,	Name of Unit Graph Models c terminology of Graph, Gra ks, Information networks, S as, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi araph connected graph, disconnect	aph Models, Soo Software Design Irnaments. Intel graph, Mat Sm of graphs.	Teaching Hours 4 cial network n Applicatio 5 trix represen 8 nponent, Cut	CO Targeted CO1, CO5 as, ons, CO2 ntation of graph, CO3 t edge, Cut vertex,	
No. 1 Graph: I Commun Transpor 2 Handsha Definitio 3 Walk, tra Cut set,	Graphs and Contraction, basic mication network distance of the second distance of the secon	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S s, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi araph connected graph, disconnectivity, N	aph Models, Soc Software Design Irnaments. Inted graph, Mat Sm of graphs.	Teaching Hours 4 cial network n Applicatio 5 trix represen 8 nponent, Cut of a graph,	CO Targeted CO1, CO5 (SS, Ons, CO2 Intation of graph, CO3 t edge, Cut vertex, Relation between	
No. 1 Graph: I Commun Transpor 2 Handsha Definition 3 Walk, tra Cut set, Vertex	Graphs and Contract of the second sec	Name of Unit Graph Models c terminology of Graph, Gra ks, Information networks, , as, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi fraph connected graph, disconnectivity, M dge connectivity and Min	aph Models, Soo Software Design Irnaments. Inted graph, Mat Sm of graphs. Inted graph, com Inimal degree of nimal degree of	Teaching Hours 4 cial network n Applicatio 5 trix represen 8 nponent, Cut of a graph, of a graph,	CO Targeted CO1, CO5 as, ons, CO2 ntation of graph, CO3 t edge, Cut vertex, Relation between ,Weighted graph,	
No. 1 Graph: I Commun Transpor 2 Handsha Definitio 3 Walk, tra Cut set, Vertex of Shortest	Graphs and O Definition, basic nication network tation network Graph Isomo king lemma, Sp on of isomorphi Connected G ail, path, cycle, Vertex connect connectivity, e path algorithm,	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S s, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi araph connected graph, disconnect tivity, edge connectivity, M dge connectivity and Min , Dijkstra's algorithm	aph Models, Soc Software Design Irnaments. Inted graph, Mat Sm of graphs. Inimal degree of nimal degree of	Teaching Hours 4 cial network n Application 5 trix represen 8 nponent, Cut of a graph, of a graph,	CO Targeted CO1, CO5 (SS, Ons, CO2 Intation of graph, CO3 t edge, Cut vertex, Relation between ,Weighted graph,	
No. 1 Graph: I Commun Transpor 2 Handsha Definitio 3 Walk, tra Cut set, Vertex of Shortest 4	Graphs and O Definition, basic nication network tation network Graph Isomo king lemma, Sp on of isomorphi Connected G ail, path, cycle, Vertex connect connectivity, e path algorithm, Eulerian and	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S s, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi araph connected graph, disconnect tivity, edge connectivity, M dge connectivity and Min , Dijkstra's algorithm Hamiltonian Graphs .	aph Models, Soc Software Design Irnaments. Inted graph, Mat Sm of graphs. Inimal degree of nimal degree of	Teaching Hours 4 cial network n Application 5 trix represen 8 nponent, Cut of a graph, of a graph, of a graph,	CO Targeted CO1, CO5 (SS, ONS, CO2 Intation of graph, CO3 t edge, Cut vertex, Relation between ,Weighted graph, CO3	
No. 1 Graph: I Commun Transpon 2 Handsha Definitio 3 Walk, tra Cut set, Vertex of Shortest 4 The Kom	Graphs and Contract of the second sec	Name of Unit Graph Models e terminology of Graph, Gra ks, Information networks, S as, Biological networks, Tou orphism pecial Types of Graph, Dire sm,Examples on isomorphi raph connected graph, disconnectivity, M dge connectivity and Min , Dijkstra's algorithm Hamiltonian Graphs . Bridge problem, Euler's pat	oph Models, Soo Software Design Irnaments. Inter degraph, Mat Sm of graphs. Inimal degree of Inimal degree of Inimal degree of Inimal degree of	Teaching Hours 4 cial network n Applicatio 5 trix represen 8 nponent, Cut of a graph, of a graph, of a graph	CO Targeted CO1, CO5 (s, ons, CO2 ntation of graph, CO3 t edge, Cut vertex, Relation between ,Weighted graph, CO3 graph, Fleury's	

Hamiltonian graph: Traveling Salesman problem, Chinese Postman problem.					
5 Trees 8 CO4					
Defin	tion of tree, basic terminology of tree, properties of trees,	Eccentricity	of a vertex,		
Centre	diameter, radius of a tree, Spanning Tree, Chords and bra	inches of Spar	nning Tree,		
Shorte	t spanning tree, Kruskal's algorithm, M-ary tree, binary tr	ee, Tree trave	ersal, Ordered		
rooted	tree, polish notation, arborescence.				
Refer	nce Books				
1. K	nneth Rosen, Discrete Mathematics and It's Applications,	Tata McGrav	w Hill, Seventh		
Ed	Edition.				
2. N	2. Narsingh Deo, Graph Theory with applications to computer science and engineering,				
Pr	ntice Hall.				
3. Do	ugals B. West, Introduction to Graph Theory, Pearson Edu	cation, Secon	nd edition.		

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-II DS156P : Lab Course on DS155T (Graph Theory)

No. of	Teaching	ŀ	Examination Scheme		
Credits:	2 Scheme	0	Continuous Evaluation:	15 Marks	
	Practical: 4	4 F	End Semester :	35 Marks	
	Hours/Wee	ek			
Prerequi	sites	I			
• Ba	sics of mathemat	ics, Set T	ĥeory		
Objective	es				
1. To int	roduce students al	oout grap	h, graph models, types o	of graph, connectivity, applic	ations of
graph	theory.				
2. To kı	now how to find sh	ortest pa	th for different Eulerian	and Hamiltonian circuit.	
3. To in	troduce students a	bout Tree	es, applications of trees,	binary tree, tree traversal, s	panning
trees.					
4. To kı	now how to find m	inimum s	spanning trees.		
5. To m	ake students famil	iar with t	he use of all these conce	epts as tools in other areas of	the
cours	e curriculum.				
6. To kı	now how to use M	axima sof	ftware.		
Course C	outcomes				
On Comp	letion of this cours	se, studen	it will be able to :	C 1	
COI: Un	derstand the graph	, and graj	ph models, terminology	of graph.	
CO2: Stu	dents can solve ex	amples o	n adjacency and inciden	ce matrix.	
	ntify the Euler tou	rs and Ha	amiltonian cycle and fin	a snortest path.	
CO4: AD	dents compute the	snortest s	spanning trees.	troffic flow	
CO5: Stu	dents can solve the	e problen e problen	is on theory using Maxi	ma Softwara	
CO0. Stu	dents can solve th	e problem	is on theory using waxi	illa Software.	
Sr.No.		Lis	t of Practical Assignm	ents	Hours
1	Problem Solving	on Unit	1: Graphs and Graph Me	odels (Written)	4
2	Problem Solving	on Unit 2	2: Graph Isomorphism	(Written)	4
3	Problem Solving	on Unit 2	3: Connected Graph (W	/ritten)	4
4	Problem Solving	on Unit 4	4: Eulerian and Hamilto	onian Graphs (Written)	4
5	Problem Solving	on Unit :	5: Trees (Written)		4
6	Problem Solving	on Unit	1: Graphs and Graph Me	odels (Using Maxima	8
	Software)				
7	Problem Solving	on Unit 2	2: Graph Isomorphism	(Using Maxima Software)	8
8	Problem Solving	on Unit 3	3: Connected Graph (U	sing Maxima Software)	8
9	Problem Solving	on Unit 4	4: Eulerian and Hamilto	onian Graphs (Using	8
	Maxima Softwar	e)			
10	Problem Solving	on Unit :	5: Trees (Using Maxim	a Software)	8

- 1. Kenneth Rosen, Discrete Mathematics and It's Applications, Tata McGraw Hill, Seventh Edition.
- 2. Narsingh Deo, Graph Theory with applications to computer science and engineering, Prentice Hall.
- 3. Dougals B. West, Introduction to Graph Theory, Pearson Education, Second edition.

Savitribai Phule Pune University B.Sc. Data Science (Pattern 2024) Semester-II

SEC151DS : Lab Course on Excel and Advanced Excel

No. of C	redits:	Teaching	Scheme	Exan	nination Sch	ieme
02		Practical:	4 Hrs/Week	Cont	inuous Evalı	ation:15 Marks
				End S	Semester :	35 Marks
Prerequi	sites					
•	Basic Compute	r Skills and	Mathematics Skill.			
Objectiv	es					
• To familiarize the student in introducing and exploring MS excel.						
•	To provide diff	erent ways	of representation and	l exploi	ratory data a	nalysis in excel.
•	To prepare the	students to	use excel in their pro	ject wo	orks	
•	Analyze data li	ke a profess	ional.			
Course (Dutcomes					
On Comp	oletion of this cou	rse, student	will be able to -			
CO1: To	Implement funda	mental cond	cept of Microsoft Exe	cel		
CO2: Per	form calculations	in excel an	d apply excel function	ons.		
CO3: Rej	present data using	charts and	diagrams			
CO4: Des	sign advanced gra	aphic presen	tations on stored dat	a.		
CO5: Per	form various adv	anced data f	tools and data analyti	ics.		~~~~
Unit		Name of	f Unit		Teaching	CO Targeted
NO.	Introduction to	Mionacti	Even		Hours	<u>CO1</u>
	miroduction to				1	COI
Conce Vorio	us Data Tumas	K & WOIK SI	leets			
• Valio	us Data Types	a with data	Call and Taxta			
• Using	ing Domoving &	s with data,	f Columna & Doura			
• Insert	ing, Removing &	Domana	I Columnis & Rows			
• WORK	ing with Data and	I Ranges				
• Enter						
• Savin	g & quitting wor	ksneet	• .• • • • •			
• Open	ing and moving a	round in an	existing worksheet			
• 100lt	bars and menu, ke	yboard shoi				
• WORK	ing with single	and multip	in a hotmoor work by	ing, re	naming, mo	ving, adding and
	ng, copy in gentr		ing between work bo	JOKS		
• Differ	rent views of wo	ork sneets	Culitting ato			
• Colur	In Freezing, Lab	els, Hiding,	Splitting etc.	1 /	• 1 4 - 1	
	Earmula Earm	s with Data	and Text; Advanced	1 paste	special techr	Inques
<u> </u>	rormulas , Func	cuons and c	charts in Excel		1	01,002,003
• Use o	of Formulas					

•	Calc	lations and Functions				
•	Chart Tools					
•	Diffe	rent types of charts and their use				
•	Logi	cal Functions				
•	Text	Functions				
•	Date	and Time Functions				
•	Look	ups.				
	3	Advance Data Tools	4	CO5		
•	Wha	-if-Analysis- Goal Seek, Data Table				
٠	Scen	ario Manager				
٠	Form	atting Charts, 3D Graphs				
	4	Advanced Graphing and Charting	5	CO3,CO4		
•	Form	atting and customizing Pivot tables				
٠	Usin	g advanced options of Pivot tables, Pivot charts				
٠	Line	Bar and Pie charts				
•	Scatt	er plots				
٠	Histo	grams.				
	5	Analytics using Excel	7	CO5		
٠	Data	analysis using normal chart				
•	Regr	ession in Excel				
•	Corr	elation, stddev, average, ANOVA				
Re	eferen	ce Books				
1.	Mast	ering MS Excel: Functions and Formulas, Webtech (Kha	anna Public	ations)		
2.	Micr	osoft Excel 2019 Data Analysis and Business Modeling,	Wayne Wi	nston, 2019		
3.	Adva	nce Excel 2016, training Guide, By Ritu Arora				