M Sc DATA SCIENCE

LOCF SYLLABUS 2023

Department of Data Science

School of Computing Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. Optimal Resource Utilization: Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.

2. Horizontal Mobility for Students: Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.

3. Credit-Transfer Across Disciplines (CTAD): The existing curricular structure, compliant with regulations from entities such as TANSCHE and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.

4. Promotion of Human Excellence: Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.

5. Emphasis on Internships and Projects: Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.

6. Addressing Stakeholder Needs: The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

Credit system

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 110 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

Course: A course refers to a theory, practical, or a combination of both that is done within a semester.

Course Outcomes (COs): These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

Programme: This term pertains to the specialization or discipline of a degree programme.

Programme Outcomes (POs): POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

Programme Educational Objectives (PEOs): PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

Some important terminologies

Core Courses (CC): *These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.*

Common Core (CC): *A common core course is a shared educational element encompassing fundamental topics across disciplines within a school. It promotes interdisciplinary comprehension and collaboration among students by providing a foundational understanding of key subjects essential for academic and professional success across diverse fields of study.*

Elective Courses (ES): *Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.*

Generic Elective Courses (EG): *These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for generic elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AE): *AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.*

Skill Enhancement Course (SE): *SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.*

Self-paced Learning (SP): *This course promotes independent learning habits among students and they have to undergo the course outside the regular class hours within a specified timeframe.*

Comprehensive Examinations (CE): *These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.*

Extra Credit Courses: *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across five semesters (2 - 6). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

Outreach Programme (OR): *It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.*

Course Coding

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

23	**UXX**	**0**	**XX**	**00/X**
Year of Revision	PG Department Code	Semester Number	Course Specific Initials	Running Number/with Choice

Course Specific Initials

CC - Core Course
CP - Core Practical
ES - Elective
AE - Ability Enhancement Course
SP - Self-paced Learning
EG - Generic Elective
PW - Project and Viva Voce
CE - Comprehensive Examination
OR - Outreach Programme
IS – Internship

EVALUATION PATTERN

Continuous Internal Assessment

Sl No	Component	Marks Alloted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Three Components (15 + 10 + 10)	35
4	Library Referencing (30 hours)	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) comprising 15 multiple choice questions (10 questions at K1 level and 5 questions at K2 level); The second and the third components are decided by the course in-charge.*

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="3">Duration: 2 Hours</td><td colspan="6">Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K levels</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (compulsory)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (compulsory)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either…or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory.
(Note: two questions on K4 and one question on K5)</td><td></td><td></td><td></td><td>1</td><td>1*</td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td rowspan="3">For courses with K6 as the highest cognitive level: Mid Sem: two questions on K4 and one question on K5; End Sem: two questions on K5 and one question on K6)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1*</td></tr>
<tr><td colspan="8">Total</td><td>60</td></tr>
</table>

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours						**Maximum Marks: 100**
UNIT	**Section A** *(Compulsory)*	**Section B** *(Compulsory)*	**Section C** *(Either…or type)*	**Section D** *(3 out of 5)*		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2	2	2	2*	2*	1*
UNIT II	2	2	2			
UNIT III	2	2	2			
UNIT IV	2	2	2			
UNIT V	2	2	2			
Marks	**10 × 1 = 10**	**10 × 3 = 30**	**5 × 6 = 30**	**3 × 10 = 30**		

** For courses with K6 as the highest cognitive level wherein one question each on K4, K5 and K6 is compulsory.*
(Note: two questions each on K4 and K5 and one question on K6)

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(A member from the Department other than the course instructors)*	100
• Self-paced Learning • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship	100	-	100
• Skill Enhancement Course: Soft Skills	100	-	100
• Project Work and Viva Voce	100	100	100

Grading System

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \ and \ CGPA = \frac{\sum_{i=1}^{n} C_i Gp_i}{\sum_{i=1}^{n} C_i}$$

$$WAM = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - Marks obtained for the Course i

*n - Number of Courses **passed** in that semester*

WAM - Weighted Average Marks

Table - 1: Grading of the Courses for PG

Mark Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	0	RA

Table - 2: Grading of the Final Performance for PG

CGPA	Grade	Performance
9.00 and above	O	Outstanding*
8.00 to 8.99	A+	Excellent*
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	RA	Re-appear

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered "Very Good".*

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Graduates will be able to apply data analytical skills that rely on mathematical and statistical methods to solve problems in a data-driven world.
2. Graduates will be able to analyse and interpret complex data to produce actionable insights
3. Graduates will be able to understand the nuances of data analytical skills to evolve innovative ideas and communicate the social relevance and impact of their analytical findings
4. Graduates will become analytical experts and data entrepreneurs with exemplary behaviour safeguarding the public interest.
5. Graduates will uphold professional ethics, values, standards and social responsibilities to attain a better and more sustainable future.

PROGRAMME STRUCTURE				
Semester	**Course Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	10	50	47
1 - 4	Core Practical	4	16	12
1, 2, 4	Elective	4	20	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	-	-	-
4	Internship	1	-	2
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	20	17
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Program	-	-	4
	Total	**28**	**120**	**110(9)**

M Sc DATA SCIENCE							
Course Details					Scheme of Exams		
Sem	Course Code	Title of the Course	Hours	Credits	CIA	SE	Final
1	23PDS1CC01	**Core Course - 1:** Fundamentals of Data Science	6	6	100	100	100
	23PDS1CC02	**Core Course - 2:** Mathematics for Data Science	6	5	100	100	100
	23PDS1CC03	**Core Course - 3:** Statistics - 1	6	5	100	100	100
	23PDS1ES01	**Elective - 1:** Data Structures and Algorithms	5	3	100	100	100
	23PDS1ES02	**Elective - 2:** Java Programming	5	3	100	100	100
	23PDS1AE01	**Ability Enhancement Course:** Data Science Using Excel	2	1	100	-	100
		Total	**30**	**23**			
2	23PDS2CC04	**Core Course - 4:** Statistics - 2	5	5	100	100	100
	23PDS2CC05	**Core Course - 5:** Python Programming	4	4	100	100	100
	23PDS2CP01	**Core Practical - 1:** Python Programming	4	3	100	100	100
	23PDS2CP02	**Core Practical - 2:** R Programming	4	3	100	100	100
	23PDS2SP01	**Self-paced Learning:** MEAN Stack*	-	2	50	50	50
	23PDS2ES03A	**Elective - 3:** Software Engineering for Data Science	5	4	100	100	100
	23PDS2ES03B	**Elective - 3:** Distributed Systems					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	-	**Generic Elective - 1 (WS):** Refer ANNEXURE 1	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
		Total	**30**	**27 (3)**			
3	23PDS3CC06	**Core Course - 6:** Machine Learning	5	5	100	100	100
	23PDS3CC07	**Core Course - 7:** Artificial Intelligence and Data Science	4	4	100	100	100
	23PDS3CC08	**Core Course - 8:** Core Industry Module: Business Analytics	4	4	100	100	100
	23PDS3CC09	**Core Course - 9:** Research Methodology	5	4	100	100	100
	23PDS3CP03	**Core Practical - 3:** Machine Learning	4	3	100	100	100
	23PDS3CP04	**Core Practical - 4:** Artificial Intelligence	4	3	100	100	100
	-	**Generic Elective - 2 (BS):** Refer ANNEXURE 2	4	3	100	100	100
	23PDS3IS01	Internship	-	2	100	-	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2	-	(3)			
		Total	**30**	**28 (3)**			
4	23PDS4CC10	**Core Course - 10:** Cloud Computing	5	5	100	100	100
	23PDS4ES04A	**Elective - 4:** Deep Learning	5	4	100	100	100
	23PDS4ES04B	**Elective - 4:** Image Recognition					
	23PDS4PW01	Project Work and Viva Voce	20	17	100	100	100
	23PDS4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3	-	(3)			
		Total	**30**	**28 (3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	-	4			
1 - 4		**Total (2 years)**	**120**	**110 (9)**			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Passed by	***Board of Studies held on 18.12.2023***
Approved by	***48th Academic Council Meeting held on 27.03.2024***

ANNEXURE 1
Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SCS	23PCA2EG01	Applied Statistics Using R
	23PCS2EG01	Mobile Adhoc Networks (MANET)
	23PMA2EG01A	Mathematical Foundations for Computer Applications
	23PMA2EG01B	Mathematical Foundations for Computer Science

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI3EG02	First Aid Management
	23PBT3EG02	Food Technology
	23PBO3EG02	Horticulture and Landscaping
SLAC	23PEN3EG02	English for Effective Communication
SMS	23PCO3EG02	Basics of TallyPrime
	23PCC3EG02	Dynamics of Human Behaviour in Business
	23PCP3EG02	Social Psychology
	23PEC3EG02	Managerial Economics
	23PHR3EG02	Counselling and Guidance
SPS	23PCH3EG02	Health Science
	23PEL3EG02	Computer Hardware and Networks
	23PPH3EG02A	Physics for Competitive Exams
	23PPH3EG02B	Nanoscience

**Offered to students from other Schools*

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1CC01	**Core Course - 1:** Fundamentals of Data Science	6	6

Course Objectives
To Understand Fundamental Concepts of Graph Theory.
To impart knowledge on Trees and Graph Theoretic algorithms.
To understand logical connectives, duality law and normal forms in logic.
To gain proficiency in set theory and its operations.
To explore algebraic structures such as lattices and Boolean algebra.

UNIT I: Introduction of Data Science **(18 Hours)**

Data Science - Data science Venn diagram - Basic terminology - Data science case studies- Types of data - levels of data- Types of data analytics - Descriptive Analytics-Diagnostic analytics- Predictive analytics- Prescriptive analytics- Five steps of Data science

UNIT II: Mathematical Preliminaries **(18 Hours)**

Basic Maths - mathematics as discipline - basic symbols and terminology -linear algebra. Basic Probability - definitions- probability - Bayesian vs frequentist - compound events - conditional probability - rules of probability.

UNIT III: Data Mining and Data Warehousing **(18 Hours)**

Introduction to Data warehousing - Design consideration of data warehouse - Data loading process - case study - Data mining - Data mining techniques - Tools and platforms - case study

UNIT IV: Visualizing Data **(18 Hours)**

Exploratory Data Analysis - Developing the visual aesthetic - chart types - Great visualizations - Reading graphs - Interactive visualizations

UNIT V: Data Science - Recent Trends **(18 Hours)**

Applications of Data Science, recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Teaching Methodology	Lecture-based instruction, Project-based learning, Discovery Learning

Books for Study

1. Sinan, O. (2016). *Principles of Data Science*. Packt Publishing.
2. Maheshwari,A. (2023). *Data Analytics Made Accessible,* (2nd Ed.). Amazon Digital Services.
3. Skiena, S. S. (2017). *The Data Science Design Manual*. Springer International Publishing

Books for Reference

1. Jean, H. (2023). *Data Science*. Certybox Education.
2. Pierson, L. (2021). *Data Science for Dummies*. John Wiley & Sons.
3. Grus, J. (2019). *Data Science from Scratch: First principles with python*. O'Reilly Media.
4. Blum, A., Hopcroft, J. & Kannan, R. (2020). *Foundations of Data Science*. Cambridge University Press.

Websites and eLearning Sources

1. https://www.analyticsvidhya.com/
2. https://www.simplilearn.com
3. https://www.ibm.com/in-en/topics/data-science
4. https://www.mygreatlearning.com/blog/what-is-data-science/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	define the terms "data" and "analytics" and explain their different types.	**K1**
CO2	explain the basic mathematical concepts used in data science.	**K2**
CO3	classify the different types of data intensive operations and tools.	**K3**
CO4	describe the five steps of the data science process.	**K4**
CO5	identify the different tools and methods for analysing data.	**K5**
CO6	analyse the recent potential applications and development of data science.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PDS1CC01**			**Core Course - 1:** Fundamentals of Data Science						**6**	**6**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	2	3	2	2	2	2	3	2	2	**2.2**
CO3	3	2	3	2	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	3	3	2	1	2	3	3	2	1	**2.2**
CO6	2	3	3	2	1	2	3	3	2	1	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1CC02	**Core Course - 2:** Mathematics for Data Science	6	5

Course Objectives
To introduce students to the field of data science and its various applications
To provide students with a foundation in the mathematical and statistical concepts that are essential for data science
To teach students how to collect, clean, and analyse data using data mining and data warehousing techniques
To train students in the use of visualization techniques to communicate the results of their data analysis
To expose students to the latest trends in data science and its applications

UNIT I: Vectors and Matrices **(18 Hours)**

Vectors and Linear Combinations-Lengths and Angles from Dot Products-Matrices and Their Column Spaces-Matrix Multiplication AB and CR Solving Linear Equations Ax = b - Elimination and Back Substitution-Elimination Matrices and Inverse Matrices-Matrix Computations and A = LU-Permutations and Transposes

UNIT II: The Four Fundamental Subspaces **(18 Hours)**

Vector Spaces and Subspaces-Computing the Nullspace by Elimination: A = CR-The Complete Solution to Ax = b - Independence, Basis, and Dimension-Dimensions of the Four Subspaces

UNIT III: Orthogonality and Determinants **(18 Hours)**

Orthogonality of Vectors and Subspaces-Projections onto Lines and Subspaces-Least Squares Approximations-Orthonormal Bases and Gram-Schmidt-The Pseudo inverse of a Matrix 3 by 3 Determinants and Cofactors-Computing and Using Determinants-Areas and Volumes by Determinants

UNIT IV: Eigenvalues and Eigenvectors **(18 Hours)**

Diagonalizing a Matrix-Symmetric Positive Definite Matrices-Complex Numbers and Vectors and Matrices-Solving Linear Differential Equations

UNIT V: The Singular Value Decomposition (SVD) and Linear Transformations **(18 Hours)**

Singular Values and Singular Vectors-Image Processing by Linear Algebra-Principal Component Analysis (PCA by the SVD) The Idea of a Linear Transformation-The Matrix of a Linear Transformation-The Search for a Good Basis

Teaching Methodology	Lecture-based instruction, Technology-based learning, Group learning, Individual learning, Inquiry-based learning

Book for Study

1. Strang, G. (2023). *Introduction to Linear Algebra,* (6th Ed.). Wellesley - Cambridge Press.

Books for Reference

1. Lay, D., Lay, S. & McDonald, J. (2014). *Linear Algebra and its Applications,* (5th Ed.). Pearsons.
2. Axler, S. (2015). *Linear Algebra Done Right (Undergraduate Texts in Mathematics),* (3rd Ed.). Springer.
3. Hefferon, J. (2020). *Linear Algebra,* (4th Ed.). Orthogonal Publishing L3c.
4. Philips, J. M. (2021). *Mathematical Foundations for Data Analysi,*. (1st Ed.). Springer Nature Switzerland AG.

Website and eLearning Source

1. https://joshua.smcvt.edu/linearalgebra/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recall and reproduce fundamental mathematical concepts relevant to data science	**K1**
CO2	explain the underlying principles of mathematical techniques and interpret various fundamental subspaces.	**K2**
CO3	apply and utilize eigenvalue and eigenvector concepts to analyze the behavior of linear transformations and diagonalize matrices.	**K3**
CO4	analyze and evaluate different linear transformations in terms of their effects on vector spaces and subspaces.	**K4**
CO5	evaluate the impact of linear transformations on data quality, interpretability, and computational complexity in various data science scenarios.	**K5**
CO6	formulate creative solutions by applying mathematical techniques to optimize linear transformations and matrix operations in data science applications.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PDS1CC02**			**Core Course - 2:** Mathematics for Data Science						**6**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	2	3	2	3	**2.5**
CO2	2	3	3	2	1	2	3	2	1	3	**2.2**
CO3	3	2	3	2	2	3	2	2	2	2	**2.3**
CO4	3	3	2	2	1	3	3	3	2	3	**2.5**
CO5	2	3	3	2	2	3	3	2	2	3	**2.5**
CO6	2	3	3	2	1	3	3	2	2	3	**2.4**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1CC03	**Core Course - 3:** Statistics - 1	6	5

Course Objectives
To introduce students to the field of data science and its various applications
To provide students with a foundation in the mathematical and statistical concepts that are essential for data science
To teach students how to collect, clean, and analyse data using data mining and data warehousing techniques
To train students in the use of visualization techniques to communicate the results of their data analysis
To expose students to the latest trends in data science and its applications

UNIT I: Introduction to Statistics **(18 Hours)**

Introduction-Data Collection and Descriptive Statistics-Inferential Statistics and Probability Models-Populations and Samples-A Brief History of Statistics- **Organization and Presentation of Data**-Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions

UNIT II: Descriptive Statistics **(18 Hours)**

Introduction-Describing Data Sets-Frequency Tables and Graphs-Relative Frequency Tables and Graphs-Grouped Data, Histograms, Ogives, and Stem and Leaf Plots-Summarizing Data Sets- Sample Mean, Sample Median, and Sample Mode-Sample Variance and Sample Standard Deviation-Sample Percentiles and Box Plots-Chebyshev's Inequality-Normal Data Sets-Paired Data Sets and the Sample Correlation Coefficient - **Correlation:** Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

Unit III: Random Variables and Expectation **(18 Hours)**

Random Variables-Types of Random Variables-Jointly Distributed Random Variables- Independent Random Variables-Conditional Distributions-Expectation-Properties of the Expected Value-Expected Value of Sums of Random Variables-Variance-Covariance and Variance of Sums of Random Variables-Moment Generating Functions-Chebyshev's Inequality and the Weak Law of Large Numbers- **Special random variables:** The Bernoulli and Binomial Random Variables-Computing the Binomial Distribution Function-The Poisson Random Variable-Computing the Poisson Distribution Function-The Hypergeometric Random Variable- The Uniform Random Variable- Normal Random Variables-Exponential Random Variables-The Poisson Process-The Gamma Distribution-Distributions Arising from the Normal-The Chi- Square Distribution-The t-Distribution-The F Distribution-The Logistics Distribution

UNIT IV: Distributions of Sampling Statistics **(18 Hours)**

Introduction-The Sample Mean-The Central Limit Theorem-Approximate Distribution of the Sample Mean, the need for larger samples -The Sample Variance-Sampling Distributions from a Normal Population-Distribution of the Sample Mean, Joint Distribution of X and SSampling from a Finite Population- **Parameter estimation:** Introduction-Maximum Likelihood Estimators-Interval Estimates-Confidence Interval for a Normal Mean When the Variance is Unknown-Confidence Intervals for the Variance of a Normal Distribution - Estimating the Difference in Means of Two Normal Populations-Approximate Confidence Interval for the Mean of a Bernoulli Random Variable-Confidence Interval of the Mean of the Exponential Distribution-The Bayes Estimator

UNIT V: Basics and Elements of Probability **(18 Hours)**

Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye's theorem and its applications-Introduction-Sample Space and Events- Venn Diagrams and the Algebra of Events-Axioms of Probability-Sample Spaces

Having Equally Likely Outcomes

Teaching Methodology	Lecture, Problem solving and case studies, Collaborative learning, Interactive online sources, Visualization techniques

Books for Study

1. Ross, S. M. (2023). *Introduction to Probability and Statistics for Engineers and Scientists*, (5th Ed.). Elsevier Academic Press.
2. Rohatgi, V. K., & Saleh, E. (2015). *An Introduction to Probability and Statistics*, (3rd Ed.). John Wiley & Sons Inc.
3. Gupta, S. C., & Kapoor, V. K. (2014). *Fundamentals of Mathematical Statistics*, (11th Ed.) Sultan Chand & Sons.

Book for Reference

1. Frost, J. (2020). *Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries*. Jim Publishing.

Websites and eLearning Sources

1. https://onlinestatbook.com/2/ https://www.simplilearn.com/tutorials/statistics-tutorial
2. https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-dataanalysts-69d93a05aae7

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, the students will be able to	
CO1	recall the basic statistical concepts, formulas, and definitions	**K1**
CO2	interpret the statistical findings and results in a clear and coherent manner	**K2**
CO3	apply the different statistical Methods on datasets	**K3**
CO4	analyse and evaluate the validity and reliability of statistical data	**K4**
CO5	determine the shape of the distribution of data	**K5**
CO6	design and execute statistical experiments or studies to investigate specific research questions	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**	**Credits**	
1	**23PDS1CC03**			**Core Course - 3:** Statistics - 1					**6**	**5**	
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	2	3	2	2	2	2	3	2	2	**2.2**
CO3	3	2	3	2	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	3	3	2	1	2	3	3	2	1	**2.2**
CO6	2	3	3	2	1	2	3	3	2	1	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1ES01	**Elective - 1:** Data Structures and Algorithms	5	3

Course Objectives
To understand fundamental concepts of Data Structures
To enhance the student's ability to deal with problem solving techniques
To enable the students for appropriate use of hashing techniques
To enrich the proper understanding of various sorting techniques
To choose appropriate graph techniques that the students can apply in various fields.

UNIT I: Basic Concepts **(15 Hours)**

Basic steps in complete development of Algorithm - Analysis and complexity of Algorithm - Asymptotic notations - Problem Solving techniques and examples. ADT: List ADT, Stacks ADT, Queue ADT

UNIT II: Algorithm Design Mode **(15 Hours)**

Greedy Method - Divide and Conquer - Dynamic Programming - Backtracking - Branch and Bound Trees: Preliminaries Binary Tree, Search Tree ADT, Binary Search Trees, AVL Trees, Tree Traversals, B-Trees

UNIT III: Hashing **(15 Hours)**

General Idea, Hash Function, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing, Priority Queues, Model, Simple Implementations, Binary Heap, Applications

UNIT IV: Sorting **(15 Hours)**

Sorting - Preliminaries, Insertion Sort, Shell Sort, Heap Sort, Merge Sort, Quick Sort, External Sorting

UNIT V: Graphs **(15 Hours)**

Definitions, Topological Sort, Shortest Path Algorithm, Minimum Spanning Tree, Application of Depth First Search. Theory of NP-Completeness: Formal language framework,
Complexity classes - P, NP - NP Reducibility and NP-Complete, NP-Hard

Teaching Methodology	Instructive method, Problem solving, Group Discussion

Books for Study

1. Aho Hopcroft, J. E., & Ullman, J. D. (2009). *Design and Analysis of Computer Algorithms*, (1st Ed.). Addison-Wesley.
2. Horowitz., & Sahani. (2008). *Fundamentals of Computer Algorithms*, (2nd Ed.). Computer Science Press.
3. Weiss. (2002). *M. A. Data Structure and Algorithm Analysis in C*, (2nd Ed.). Pearson Education.

Books for Reference

1. Baase, S. & Gelder, A. V. (2008). *Computer Algorithms Introduction to Design and Analysis*. Pearson Education.
2. Goodrich, M. T. & Tamassia, R. (2006). *Algorithm Design: Foundations, Analysis, and Internet examples*. Wiley.

Websites and eLearning Sources

1. https://www.programiz.com/dsa
2. https://www.tutorialspoint.com/data_structures_algorithms/index.htm
3. https://www.javatpoint.com/data-structure-tutorial

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recall the basic concepts of data structures and algorithms	**K1**
CO2	interpret the algorithm design mode	**K2**
CO3	apply the different hashing techniques	**K3**
CO4	analyze the sorting techniques	**K4**
CO5	determine the usages of graphs	**K5**
CO6	discuss the various NP completeness	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PDS1ES01**			**Elective - 1:** Data Structures and Algorithms						**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	1	2	2	2	2	2	3	2	2	**2**
CO2	3	2	3	1	3	3	2	2	3	3	**2.5**
CO3	2	3	3	3	3	2	2	3	2	2	**2.5**
CO4	3	2	2	2	2	3	3	3	3	3	**2.6**
CO5	2	2	1	3	2	3	2	3	2	3	**2.3**
CO6	3	2	2	2	2	2	2	2	2	2	**2.1**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1ES02	**Elective - 2:** Java Programming	5	3

Course Objectives
To develop knowledge and understand the fundamental concepts of Java Programming
To enhance the problem-solving skills with object-oriented programming
To enable the use of exception handling
To enrich a proper understanding of multithreading
To deploy event handling techniques to utilize the packages

UNIT I: Introduction to Java **(15 Hours)**

Overview - Features - Fundamental OOPS concepts - JDK - JRE - JVM -Structure of a Java program - Data types - Variables - Arrays - Operators -Keywords - Naming Conventions - Control statements, Type conversion and Casting - Scanner - String - equals(), equals Ignore Case(), length()

UNIT II: Classes and Objects **(15 Hours)**

Class - Objects - Methods - Method Overloading - Constructors - Constructor Overloading - this keyword - usage of static with data and methods - Garbage Collection - Access Control Inheritance: Concept - extends keyword - Single and Multilevel Inheritance - Composition - super keyword - Method Overriding - Abstract Classes - Dynamic Method Dispatch - Usage of final with data, methods and classes. Packages and Interfaces: Concepts - package and import keywords - Defining, Creating and Accessing a Package - Interfaces - Multiple Inheritance in Java, Extending and Initialising fields in Interfaces.

UNIT III: Exception Handling **(15 Hours)**

Exception handling- Types of Exceptions- try, catch, throw, throws and finally keywords - User defined Exceptions. JDBC: Database Connectivity- Types of JDBC drivers- Executing statements Prepared statements- Callable statements - Mapping SQL types to Java Result Set Meta data

UNIT IV: Multithreading **(15 Hours)**

Introduction - Life Cycle of a Thread, Thread class and Runnable Interface, Thread Priorities, Synchronisation. GUI Programming with JavaFX: JavaFX Basic Concepts - Packages - Stage and Scene Classes - Nodes and Scene Graphs - Layouts - The Application Class and the Lifecycle Methods - Launching a JavaFX Application - JavaFX Application Skeleton - Compiling and Running -Application Thread. JavaFX Controls: Label - Button - Image - Radio Button - Check Box - List View Combo Box- Text Field - Scroll Pane

UNIT V: Event Handling **(15 Hours)**

Event Handling - Input Event, Action Event and Window Event. Java Library: Java.util - List, Array List

Teaching Methodology	Videos, PPT, Blackboard, Demonstration, Exercises

Book for Study

1. Schildt, H. (2014). *Java: The Complete Reference*. McGraw-Hill Education Group.

Books for Reference

1. Eckel, B. (2006). *Thinking in Java,* (4th Ed.). Pearson Education.
2. Liang, Y. D. (2015). *Intro to Java Programming, brief version*. Pearson Higher Ed.
3. Holmes, J. B. & Joyce, T. D. (2001). *Object-oriented Programming with Java*. Jones & Bartlett Learning.

Websites and eLearning Sources

1. http://docs.oracle.com/javase/tutorial/java/index.html/
2. http://www.java2s.com/Tutorial/Java/CatalogJava.htm/
3. https://www.edureka.co/blog/object-oriented-programming

ourse Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	recall the basic concepts of programming	**K1**
CO2	interpret the classes and objects	**K2**
CO3	apply the different object-oriented concepts	**K3**
CO4	analyze the usages of exception handling	**K4**
CO5	determine the GUI programming	**K5**
CO6	discuss the various types of event handling	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PDS1ES02**			**Elective - 2:** Java Programming						**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	2	2	2	2	2	2	**2.2**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.2**
CO6	3	3	2	2	2	2	2	2	2	2	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PDS1AE01	**Ability Enhancement Course:** Data Science Using Excel	2	1

Course Objectives
To understand the basic components of Excel, including worksheets, workbooks, tabs, and ribbons
To gain proficiency in worksheet basics, including data entry, formatting, and organization
To apply formulas and functions effectively to perform calculations and analyse data in Excel
To explore data visualization techniques in Excel
To learn how to create pivot tables, add slicers and timelines, and manipulate calculated fields and items

UNIT I: Getting Started with Excel **(6 Hours)**

Worksheets and Workbooks- Navigation with Keyword- Tabs and Ribbons - File Menu - Quick Access Toolbar -Excel options - Create a new workbook- Understanding Worksheet Basics

UNIT II: Protecting, Importing and exporting Data from Excel **(6 Hours)**

Protect Workbook - Protect sheet and Allow Edit Ranges- Importing data into Excel: Importing from Text - Importing from Web - Importing from Database- Exporting Data from Excel: Export to file- Export to SharePoint List

UNIT III: Perform Operations with Formulas and Functions **(6 Hours)**

Understanding formulas - operators in formula - Defined Names - Calculations - functions in formula - Logical functions - Summarizing functions - Text functions - Lookup functions - Date and Time functions - Math functions - Statistical functions

UNIT IV: Data Visualization with New Chart Types **(6 Hours)**

Chart types and when to use them - Waterfall Chart- Histogram - Box and Whisker Chart- Tree map Chart - Gantt Chart - Milestone Chart -Macros in Excel: VBA Quick View - Enabling Developer Tab - Create Macro -Record Macro

UNIT V: Putting Data into Pivots **(6 Hours)**

Understanding the terminologies- Verify the source - Format Data for Sync- Recommended Pivot Tables - Setting Pivot table default layout - Adding Slicers & Timelines - Adding / Deleting calculated fields from Pivot - Adding / Deleting calculated items from Pivot -Consolidate data from different sources in Pivot

Teaching Methodology	Demonstration and Explanation, Hands-on Practice, Individual Projects

Books for Study

1. Nigam, M. (2019). *Advanced analytics with Excel,* (2nd Ed.). BPB Publications.
2. Wayne, L. W. (2019). *Microsoft Excel 2019: Data Analysis & Business Model,* (1st Ed.). PHI Learning Pvt. Ltd.

Books for Reference

1. Zhou, H. (2020). *Learn Data Mining through Excel: A step-by-step approach for understanding Machine Learning Method,* (1st Ed). Apress.
2. Lalwani, L. (2019). *Excel 2019 all-in-one,* (1st Ed). BPB Publications

Websites and eLearning Sources

1. https://www.techtarget.com/searchenterprisedesktop/definition/Excel
2. https://www.w3schools.com/EXCEL/index.php
3. https://support.microsoft.com/en-us/office/excel-video-training-9bc05390-e94c-46af-a5b3d7c22f6990bb
4. https://www.techtarget.com/searchenterprisedesktop/definition/Excel

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, the students will be able to	**Cognitive Levels (K-Level)**
CO1	analyze and interpret data using Excel's data analysis tools	**K4**
CO2	evaluate and compare different data analysis techniques and approaches in Excel	**K5**
CO3	design and create comprehensive data visualizations, reports, and dashboards using Excel's advanced charting and visualization features	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**23PDS1AE01**		**Ability Enhancement Course:** Data Science Using Excel							**2**	**1**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	3	2	2	2	2	**2.2**
CO2	2	3	3	2	1	2	3	3	2	1	**2.2**
CO3	2	3	3	2	1	2	3	3	2	1	**2.2**
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2CC04	**Core Course - 4:** Statistics - 2	5	5

Course Objectives
To identify the four steps of hypothesis testing
To gain a thorough understanding of applied principles of statistics
To develop knowledge and skills in theoretical, computational and application-oriented statistics
To apply the methods of analysis of variance
To understand and apply the concept of non-parametric tests

UNIT I: Introduction to Statistics and Hypothesis Testing **(15 Hours)**

Population and Statistics - Finite and Infinite population - Parameter and Statistics - Types of sampling - Sampling Distribution - Sampling Error - Standard Error - Test of significance - concept of hypothesis - types of hypothesis - Errors in hypothesis-testing - Critical region - level of significance - Power of the test - p-value. **Hypothesis testing:** Introduction-Significance Levels-Tests Concerning the Mean of a Normal Population-Case of Known Variance-Case of Unknown Variance: The t-Test

UNIT II: Hypothesis Testing-II **(15 Hours)**

Students t-distribution and its properties (without proofs) - Single sample mean test - Independent sample mean test - Paired sample mean test - Tests of proportion (based on t distribution) - F distribution and its properties (without proofs) - Tests of equality of twovariances using F-test - Chi-square distribution and its properties (without proofs) - Chi-squaretest for independence of attributes - Chi-square test for goodness of fit.

UNIT III: Regression **(15 Hours)**

Introduction-Least Squares Estimators of the Regression Parameters-Distribution of the Estimators-Statistical Inferences About the Regression Parameters- The Coefficient of Determination and the Sample Correlation Coefficient-Analysis of Residuals: Assessing the Model-Transforming to Linearity-Weighted Least squares-Polynomial Regression - Multiple Linear Regression-Predicting Future Responses - Logistic Regression Models for Binary Output Data

UNIT IV: Analysis of variance **(15 Hours)**

Introduction-An Overview-One-Way Analysis of Variance-Multiple Comparisons of Sample Means-One-Way Analysis of Variance with Unequal Sample Sizes-Two-Factor Analysis of Variance: Introduction and Parameter Estimation-Two-Factor Analysis of Variance: Testing Hypotheses-Two-Way Analysis of Variance with Interaction

UNIT V: Nonparametric hypothesis tests **(15 Hours)**

Introduction-The Sign Test-The Signed Rank Test-The Two-Sample Problem-The Classical Approximation and Simulation-Wilcoxon Signed Rank Test for one and paired samples-TheRuns Test for Randomness -Median test and Mann-Whitney-Wilcoxon tests for two samples.

Teaching Methodology	Interactive Lectures, Hands-on Statistical Software Usage, Problem-Solving Sessions, Research Projects and Presentations

Books for Study

1. Sheldon, M. R. (2023). *Introduction to Probability and Statistics for Engineers and Scientists*, (5th Ed.). Elsevier Academic Press.
2. Gupta, S. C. & Kapoor, V. K. (2020). *Fundamentals of Mathematical Statistics*, (12th Ed.). Sultan Chand & Sons.
3. Caffo, B. (2016). *Statistical Inference for Data Science*, (1st Ed.). Learnpub.

Books for Reference

1. Allen, B. (2014), Downey. Think Stats - Exploratory Data Analysis, (2nd Ed.). O'reilly.
2. Kreyszig, E. (2011). *Advanced Engineering Mathematics*, (10th Ed.). Wiley Publications.
3. Frost, J. (2019). *Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries*. Jim Publishing.

Websites and eLearning Source

1. https://onlinestatbook.com/2/
2. https://www.simplilearn.com/tutorials/statistics-tutorial
3. https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-data-analysts-69d93a05aae7

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the fundamental statistical concepts, methods, and terminologies	**K1**
CO2	explain the principles and theories behind statistical methodologies and hypothesis testing	**K2**
CO3	apply various statistical techniques to analyse data and draw meaningful inferences	**K3**
CO4	analyse and evaluate statistical models, hypothesis tests, and their outcomes	**K4**
CO5	evaluate research studies, statistical analyses, and their implications for decision-making and problem-solving	**K5**
CO6	design and conduct experiments, utilizing appropriate statistical tools and methods	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PDS2CC04**			**Core Course - 4:** Statistics - 2						**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	2	3	2	2	2	2	3	2	2	**2.2**
CO3	3	2	3	2	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	3	3	2	1	2	3	3	2	1	**2.2**
CO6	2	3	3	2	1	2	3	3	2	1	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2CC05	**Core Course - 5:** Python Programming	4	4

Course Objectives
To develop knowledge and to understand the fundamental concepts of Python Programming
To enhance the problem-solving skills with control structures and loops
To enable the use of object-oriented programming
To enrich a proper understanding of exception handling
To deploy data visualization using the packages

UNIT I: Introduction to Python programming **(12 Hours)**

Introduction to python programming - Programming Style and Documentation - Programming Errors - Introduction to Graphics Programming. **Elementary Programming:** Input - Output - Identifiers - Variables, Assignment Statements and Expressions - Simultaneous Assignments - Named Constants - Numeric Data Types and Operators - Evaluating Expressions and Operator Precedence - Augmented Assignment Operators - Type Conversion and Rounding.**Mathematical Functions, Strings and Objects:** Introduction - Common Python Functions - Strings and Characters - Introduction to Objects and Methods - Formatting Numbers and Strings - Drawing various shapes with Colors and Fonts

UNIT II: Control Structure and Loops **(12 Hours)**

Selections - Introduction - Boolean Types, Values and Expressions - Generating Random Numbers - Different forms of if statements - Logical Operators - Conditional Expressions - Operator Precedence and Associativity. Loops: Introduction - while, for, Nested Loops - break and Continue

UNIT III: Object Oriented Programming Concepts **(12 Hours)**

Functions: Introduction - Defining and calling a function - Return single and multiple values - Positional, Keyword and Default Arguments - Passing Arguments by Reference Values - Modularizing Code - Function Abstraction and Stepwise Refinement - Recursion. Objects and Classes: Introduction - Defining Classes for Objects - UML Class Diagrams - Immutable vs Mutable Objects - Hiding Data Fields - Class Abstraction and Encapsulation - Object Oriented Thinking. Inheritance and Polymorphism: Superclasses and Subclasses - Overriding methods - Object class - Polymorphism and Dynamic binding.

UNIT IV: Exception Handling **(12 Hours)**

More on Strings and Special Methods - Introduction - Str class - Operator Overloading and Special Methods. **Lists** - Basics - Copying Lists - Passing Lists to Functions - Returning a List from a Function - Searching, Sorting Lists. **Multidimensional Lists** - Processing Two - Dimensional Lists - Passing Two - Dimensional Lists to Functions - Multidimensional Lists. **Tuples, Sets and Dictionaries** - Introduction - Tuples - Sets - Comparing the Performance of Sets and Lists - Dictionaries. **Files and Exception Handling** - Introduction - Text Input and Output - File Dialogs - Retrieving Data from Web - Exception Handling - Raising Exceptions - Processing Exceptions using Exception Objects - Defining Custom Exception Classes - Binary IO Using Pickling

UNIT V: Data Visualization **(12 Hours)**

Matplotlib: Pie Chart - Violin Plot - Scatter Plot - Histogram - Bar Chart - Area Plot - Quiver Plot - Mesh Plot - Contour Plot. **Seaborn:** Visualization for Categorical Variable - Visualization forContinuous Variable.

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs, Project Work

Book for Study

1. Daniel, Y.L. (2013). *Introduction to Programming using Python*. (2nd Ed.). Pearson Education.

Books for Reference

1. Motwani, B. (2020). *Data Analytics using Python*. Wiley.
2. Downey, A.B. (2016). *Think Python. How to Think Like a Computer Scientist*, (2nd Ed.). O 'Reilly Publishers.
3. Wade, C. (2022). *The Python Workshop*. (2nd Ed.). Packt.
4. Bhasin, H. (2018). *Python for Beginners*, (1st Ed.). New Age International Publishers.
5. Brown, M.C. (2018). *Python: The Complete Reference*. (4th Ed.). McGraw-Hill.

Websites and eLearning Sources

1. https://realpython.com, http://docs.python.org, http://diveintopython.org/,
2. https://www.w3schools.com/python/, https://www.tutorialspoint.com/python/index.htm

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of programming	**K1**
CO2	interpret the classes and objects	**K2**
CO3	apply the different object-oriented concepts	**K3**
CO4	analyse the usages of exception handling	**K4**
CO5	determine the Python data structure	**K5**
CO6	discuss the various types of visualization tools	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PDS2CC05**			**Core Course - 5:** Python Programming						**4**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	2	2	2	2	2	2	**2.2**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.2**
CO6	3	3	2	2	2	2	2	2	2	2	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2CP01	**Core Practical - 1:** Python Programming	4	3

Course Objectives
To develop knowledge and understand the fundamental concepts of Python Programming
To enhance the problem-solving skills with control structures and loops
To enable the use of object-oriented programming
To enrich a proper understanding of exception handling
To deploy data visualization using the packages

List of Exercises

1. Program using basic data types and operators
2. Program involving Mathematical functions and String Manipulations
3. Program using List, Tuple, Set and Dictionaries
4. Program using control statements
5. Program using loops
6. Program using classes and objects
7. Program using Inheritance
8. Program using Exception Handling
9. Data Visualization using
   Matplotlib
10. Data Visualization using
    Seaborn

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs, Project Work

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of programming	**K1**
CO2	interpret the classes and objects	**K2**
CO3	apply the different object-oriented concepts	**K3**
CO4	analyse the usages of exception handling	**K4**
CO5	determine the Python data structure	**K5**
CO6	discuss the various types of visualization tools	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
2	**23PDS2CP01**		**Core Practical - 1:** Python Programming						**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	2	2	2	2	2	2	**2.2**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.2**
CO6	3	3	2	2	2	2	2	2	2	2	**2.2**
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2CP02	**Core Practical - 2:** R Programming	4	3

Course Objectives
To develop proficiency in statistical tools and software
To enhance analytical skills through practical application
To promote critical thinking and problem-solving abilities
To cultivate effective data interpretation and communication
To encourage collaborative learning and research skills

List of Exercises

1. Program for descriptive statistics.
2. Program to perform a t-test.
3. Program to perform a simple linear regression analysis.
4. Program to perform a chi-square test on a contingency table to test for independence.
5. Program to perform a one-way ANOVA on a given dataset.
6. Program for performing a two-sample t-test to compare means of two independent samples.
7. Program for performing nonparametric tests.
8. Program to analyze residuals from a regression model for assessing the model's adequacy.
9. Program for plotting various probability distributions.
10. Program for analysing a time series dataset.

Teaching Methodology	Hands-on Practice, Problem-Solving, Online Learning

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall key R programming, statistical, and data analysis concepts	**K1**
CO2	explain principles behind statistical methods, hypothesis testing,and R programming logic	**K2**
CO3	apply R for statistical analyses, hypothesis testing, and visualization	**K3**
CO4	analyze R outputs, interpret results, and assess statistical models	**K4**
CO5	evaluate Statistical methods and R packages for various data types	**K5**
CO6	design custom R scripts for research and data visualization	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**	**Credits**
2	**23PDS2CP02**			**Core Practical - 2:** R Programming					**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	2	3	2	2	2	2	3	2	2	**2.2**
CO3	3	2	3	2	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	3	3	2	1	2	3	3	2	1	**2.2**
CO6	2	3	3	2	1	2	3	3	2	1	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2SP01	**Self-paced Learning:** MEAN Stack	-	2

Course Objectives
To develop knowledge to understand the fundamental concepts of Java script
To enhance the skills working with MongoDB
To enable the use of express.js
To enrich a proper understanding of node.js
To deploy a form using angular.js

UNIT I: MEAN Stack

Overview - Architecture - Need - Advantages - Disadvantages - Uses of MEAN Stack - Building blocks - Setup - Deployments.

UNIT II: MongoDB

Structure - Working with MongoDB - Shell Commands - Native Commands - Models - Mongoose

UNIT III: Express

Installing and Setting Up things - Build a Web Application with Express - Authentication -Authenticate and Authorize Your Users with Passport - Communicate in Real-Time with Socket.IO

UNIT IV: Angular.js

Introduction to AngularJS - First AngularJS application - Single Page Applications - Controllers - Models - View - Expressions - Filters - Scopes - Angular Form.

UNIT V: Node.js

Overview - Setting up things - Building Blocks -Npm - Using third party packages - Working with Node.js

Teaching Methodology	Videos, PPT, Blackboard, Demonstration, Exercises

Books for Study

1. Ihrig, J.C. (2015). *Full Stack JavaScript Development with MEAN: MongoDB, Express, Angular JS, and Node.JS,* Site point.

Books for Reference

1. Naik, G.P. (2023). *MEAN Stack Web Development Explained to Novice Learners (Vol I),* Shashwat Publication.
2. Elron, E. (2016). *Pro MEAN Stack Development*, Apress.

Website and eLearning Source

1. https://www.javatpoint.com/mean-stack-tutorial
2. https://www.tutorialspoint.com/meanjs/index.htm

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of Java script	**K1**
CO2	interpret the uses of MongoDB	**K2**
CO3	apply the different express.js concepts	**K3**
CO4	analyse the usages of node.js	**K4**
CO5	determine the angular.js	**K5**
CO6	discuss the technologies to be used to create web application	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PDS2SP01**			**Self-paced Learning:** MEAN Stack						**-**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	2	2	2	2	2	2	**2.2**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.2**
CO6	3	3	2	2	2	2	2	2	2	2	**2.2**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2ES03A	**Elective - 3:** Software Engineering for Data Science	5	4

Course Objectives
To describe the Software Engineering Principles
To apply Software Life Cycle Models for Software Development
To use Requirements Engineering skills and gather Requirements
To develop a quality Software
To apply appropriate testing methodologies

UNIT I: Software and Software Engineering **(15 Hours)**

The nature of software - Software Engineering - The Software Process - Software Engineering Practice - Software Myths. **Process Models:** A Generic Process Model - Process Assessment and Improvement -Prescriptive Process Models - Product and Process. **Agile Development:** Introduction - Agility and Cost of Change - Agile Process - Scrum - Other Agile Frameworks.

UNIT II: Recommended Process Mode **(15 Hours)**

Requirements Definition - Preliminary Architectural Design - Resource Estimation - First Prototype Construction - Prototype Evaluation - Prototype Evolution - Prototype Release - Maintain Release Software. **Human Aspects of Software Engineering:** Characteristics of a Software Engineer - The Psychology of Software Engineer - The Software Team - Team Structures - The impact of social media- Global Teams. **Principles that guide practice:** Core Principles - Principles that guide each Framework Activity - Communication Principles - Planning Principles - Modeling Principles - Construction Principles - Deployment Principles

UNIT III: Understanding Requirements **(15 Hours)**

Requirements Engineering - Establishing the groundwork - Requirements Gathering - Developing Use Cases -Building the Analysis Model - Negotiating Requirements - Requirements Monitoring - Validating Requirements. Requirements Modeling - A Recommended Approach: Requirements Analysis - Scenario-Based Modeling - Class-Based Modeling - Functional Modeling - Behavioural Modeling.

UNIT IV: Design Concepts **(15 Hours)**

Design within the context of Software Engineering - The Design Process - Design Concepts - The Design Model. **Quality and Security:** Introduction - Software Quality - The Software Quality Dilemma - Achieving Software Quality. **Software Quality Assurance:** Background Issues - Elements of Software Quality Assurance - SQA Process and Product Characteristics - SQA Tasks, Goals and Metrics - Formal Approaches - Statistical SQA - Software Reliability - ISO 9000 Quality standards - SQA Plan

UNIT V: Software Testing **(15 Hours)**

Component Level: A Strategic Approach to Software Testing - Planning and Record Keeping – Test -
Case Design - White-box Testing - Black-Box Testing - Object-oriented Testing. Software Testing - **Integration Level:** Software Testing Fundamentals - Integration Testing - Artificial Intelligence and Regression Testing - Integration Testing in the OO context - Validation Testing - Testing Patterns

Teaching Methodology	Lecture-based instruction, Technology-based Learning, Group Learning, Individual Learning, Inquiry-based Learning

Book for Study

1. Pressman, Roger, S., & Maxim, B.R. (2020). *Software Engineering: A Practitioner's Approach* (9th Ed.). McGraw-Hill.

Books for Reference

1. Martin, Robert, C. (2002). *Agile Software Development: Principles, Patterns, and Practices*, Prentice Hall.
2. Schach, Stephen, R. (2008). *Object-oriented Software Engineering*, McGraw-Hill.
3. Sommerville, Ian. (2011). *Software Engineering* (9th Ed.). Pearson.

Websites and eLearning Source

1. https://www.d.umn.edu/~gshute/softeng/principles.html

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the fundamental concepts of Software Engineering	**K1**
CO2	compare and contrast the different software engineering methodologies	**K2**
CO3	apply software engineering principles and practices to develop adata science application	**K3**
CO4	analyze a software system and identify its design components	**K4**
CO5	evaluate the quality of data science applications using appropriatemetrics	**K5**
CO6	develop software models of real-world problems	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PDS2ES03A**			**Elective - 3:** Software Engineering for Data Science						**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes(PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	2	3	2	3	**2.5**
CO2	2	3	3	2	2	2	3	2	1	3	**2.3**
CO3	3	2	3	2	2	3	2	2	2	2	**2.3**
CO4	3	3	2	2	2	3	3	3	2	3	**2.6**
CO5	2	3	3	2	1	3	3	2	2	3	**2.4**
CO6	2	3	3	2	1	3	3	2	2	3	**2.4**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PDS2ES03B	**Elective - 3:** Distributed Systems	5	4

Course Objectives
To explain the significance of Distributed Systems
To explain the architecture of Distributed Systems
To relate the different types of Process role in Distributed Systems
To describe the rules and the communicating process
To examine the issues in Distributed Systems

UNIT I: Introduction to Distributed Systems **(15 Hours)**

Introduction to Distributed Systems - Design Goals - Types of Distributed Systems

UNIT II: Architectures **(15 Hours)**

Architectures - Architectural Styles - Middleware Organization - System Architecture - Example Architectures

UNIT III: Processes **(15 Hours)**

Threads - Virtualisation - Clients - Servers - Code Migration

UNIT IV: Communications **(15 Hours)**

Foundations - Remote Procedure Call -Basic RPC operation, Parameter Passing, RPC based Application Support - Message Oriented Communication - Simple Transient Messaging with Sockets, Advanced Transient Messaging, Message Oriented Persistent Communication - Multicast Communication. **Naming:** Names, Identifiers and Addresses - Flat naming - Structured naming - Attribute-based naming

UNIT V: Co-ordination **(15 Hours)** Clock Synchronisation - Logical Clocks - Mutual Exclusion - Election Algorithms - Distributed Event Management. **Consistency and Replication:** Introduction - Data-centric Consistency Models - Client-Centric Consistency Models - Replica Management. **Fault Tolerance:** Introduction

Teaching Methodology	Lecture-based Instruction, Technology-based Learning, Group Learning, Individual Learning, Inquiry-based Learning

Book for Study

1. Andrew, S. T. & Steen, M.V. (2017). *Distributed Systems: Principles andParadigms*, (3rd Ed.). Pearson.

Books for Reference

1. Coulouris, G., Dollimore, J., Kindberg, T & Blair, G. (2011). *Distributed Systems:Concepts and Design*. (5th Ed.). Addison Wesley.
2. Smith, E.J & Nair, R. (2005). *Virtual Machines: Versatile Platforms for Systems and Processes*, (1st Ed.). Morgan Kaufmann.

Website and eLearning Sources

1. https://www.tutorialspoint.com/Distributed-Systems.
2. https://link.springer.com/article/10.1007/s00607-016-0508-7

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall and describe fundamental concepts of distributed systems	**K1**
CO2	illustrate the principles of concurrency and synchronization in distributed computing, including race conditions	**K2**
CO3	evaluate and select appropriate communication protocols and middleware for specific distributed system scenarios	**K3**
CO4	analyze and diagnose common issues and challenges in distributed systems	**K4**
CO5	critique and assess the design choices of real-world distributed systems	**K5**
CO6	evaluate the trade-offs between consistency, availability, and partition tolerance (CAP theorem)	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PDS2ES03B**			**Elective - 3:** Distributed Systems						**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	2	3	2	3	**2.5**
CO2	2	3	3	2	2	2	3	2	1	3	**2.3**
CO3	3	2	3	2	2	3	2	2	2	2	**2.3**
CO4	3	3	2	2	2	3	3	3	2	3	**2.6**
CO5	2	3	3	2	1	3	3	2	2	3	**2.4**
CO6	2	3	3	2	1	3	3	2	2	3	**2.4**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

Unit I: Effective Communication & Professional Communication **(12 Hours)**

Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

Unit II: Resume Writing & Interview Skills **(12 Hours)**

Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.

Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

Unit III: Group Discussion & Personal effectiveness **(12 Hours)**

Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.

Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

Unit IV: Numerical Ability **(12 Hours)**

Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

Unit V: Test of Reasoning **(12 Hours)**

Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.

Book for study

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills.* Trichy, India: St. Joseph's College.

Books for References

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning.* S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people.* Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win.* Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar*, (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interview*s? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall various soft skill sets	**K1**
CO2	understand personal effectiveness in any managerial positions	**K2**
CO3	apply verbal and non-verbal reasoning skills to solve problems	**K3**
CO4	differentiate problems at work and home; and design solutions to maintain work-life balance	**K4**
CO5	assess growth and sustainability and infuse creativity in employment that increases professional productivity	**K5**
CO6	construct plans and strategies to work for better human society	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PSS2SE01**			**Skill Enhancement Course:** Soft Skills					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	2	3	2	3	2	3	**2.7**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	2	2	3	3	3	3	3	3	3	**2.8**
CO4	3	3	2	2	3	3	3	3	3	3	**2.8**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	2	3	3	3	3	3	**2.8**
										Mean Overall Score	**2.8 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CC06	**Core Course - 6:** Machine Learning	5	5

Course Objectives
To learn what machine learning is and how to build a simple machine learning model using Python
To choose the right machine learning classifier for a problem and train it using scikit-learn
To improve machine learning model performance using dimensionality reduction techniques
To combine different machine learning models using ensemble learning techniques
To use unsupervised machine learning to group unlabeled data and find patterns in it

UNIT I: Data Analytics and Machine Learning **(15 Hours)**

Data Analytics with Pandas and Numpy: NumPy and basic stats - Matrices - pandas library - Working with data - Null Values - Creating statistical graphs. **Giving Computers the ability to learn from data** - Introduction - Building intelligent systems totransform data into knowledge - The three different types of Machine Learning (ML) - Basicterminologies and notations - A roadmap for building ML systems - Using Python for ML **Training Simple ML Algorithms for Classification** - Early History of ML - Implementing aPerceptron learning algorithm - Adaptive linear neurons and the convergence of learning

UNIT II: Classification Algorithms and Data Preprocessing **(15 Hours)**

ML Classifiers using Scikit-Learn: Choosing a classification algorithm - Training a perceptron - Modeling class probabilities via logistic regression - Maximum margin classification with support vector machines (SVM) - Solving nonlinear problems using a kernel SVM - Decision tree learning - K-nearest neighbours: a lazy learning algorithm.**Data Preprocessing:** Missing data - Categorical data - Partitioning a dataset into separate training and test datasets - Bringing features onto the same scale - Selecting meaningful features - Assessingfeature importance with random forests

UNIT III: Dimensionality Reduction and Model Evaluation **(15 Hours)**

Compressing Data via Dimensionality Reduction: Unsupervised dimensionality reduction via principal component analysis - Supervised data compression via linear discriminant analysis - Using kernel principal component analysis for nonlinear mappings. **Best Practices for Model Evaluation and Hyperparameter Tuning** - Streamlining workflows with pipelines - Using k-fold cross-validation to assess model performance - Debugging algorithms with learning and validation curves - Fine-tuning ML models via grid search - Looking at different performance evaluation metrics

UNIT IV: Ensembles and Regression Analysis **(15 Hours)**

Combining Different Models for Ensemble Learning: Learning with ensembles - Combining classifiers via majority vote. **Bagging:** building an ensemble of classifiers from bootstrap samples - Leveraging weak learners via adaptive boosting. **Predicting Continuous Target Variables with Regression Analysis:** Linear regression - Implementing an ordinary least squares linear regression model - Fitting a robust regression model using RANSAC - Evaluating the performance of linear regression models - Using regularised methods for regression - Turning a linear regression model into a curve -polynomial regression - Dealing with nonlinear relationships using random forests

UNIT V: Clustering and Embedding ML Models **(15 Hours)**

Working with Unlabelled Data: Grouping objects by similarity using k-means - Organizingclusters as a hierarchical tree - Locating regions of high density via DBSCAN. **Introduction to Embedding a ML model into a Web Application** - Serializing fitted scikit-learn estimators - Setting up an SQLite database for data storage - Developing a web application with Flask - Turning any classifier into a web application - Deploying the web application to a public server.

Teaching Methodology	Lecture-based Learning, Project-based learning.

Books for Study

1. Corey Wade et. al., Vahid Mirjalili. (2022). *The Python Workshop*. (2nd ed.). Packs publishing.

2. Raschka, S., & Mirjalili, V. (2019). *Python Machine Learning*. (3rd ed.). Packtpublishing.

Books for Reference

1. Mueller, A.C., & Guido, S. (2016). *Introduction to Machine Learning with Python.* O'Reilly Media.
2. Alpaydin, E. (2010). *Introduction to Machine Learning*. (2nd ed.). MIT Press.
3. McKinney, W. (2018). *Python for Data Analysis.* (2nd ed.). O'Reilly Media.

Websites and eLearning Source

1. https://data-flair.training/blogs/machine-learning-tutorial/
2. https://www.geeksforgeeks.org/machine-learning/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the concept of ensemble learning	**K1**
CO2	explain the steps involved in building a machine learning system	**K2**
CO3	develop k-means clustering algorithm in Python to cluster adataset	**K3**
CO4	analyze the convergence properties of the perceptron learningalgorithm	**K4**
CO5	evaluate the performance of ensemble learning algorithms on classification tasks	**K5**
CO6	solve nonlinear classification problems using a kernel SVM	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PDS3CC06**			**Core Course - 6:** Machine Learning					**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	3	2	2	2	2	2	3	2	2	**2.2**
CO3	2	3	2	3	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	2	3	3	2	2	1	3	3	1	**2.2**
CO6	3	2	3	2	2	1	2	3	3	1	**2.2**
										Overall Mean Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CC07	**Core Course - 7:** Artificial Intelligence and Data Science	4	4

Course Objectives
To develop knowledge to understand the fundamental concepts of AI
To enhance the skills of working with knowledge representation
To enable the use of learning algorithm
To enrich a proper understanding of AI methodologies
To deploy an algorithm implementation for generative AI

UNIT I: Artificial Intelligence **(12 Hours)**

Artificial Intelligence: The AI Problems - The Underlying Assumptions -AI Techniques - The Level of the Model - Criteria for Success. **Problems, Problem Spaces & Search:** Defining the problem as a State Space Search - Production systems - Problem Characteristics - Production Systems Characteristics - Issues in the Design of Search Programs. **Heuristic Search Techniques:** Generate and Test - Hill Climbing - Best First Search - Problem Reduction - Constraint Satisfaction - Means ends Analysis.

UNIT II: Knowledge Representation **(12 Hours)**

Knowledge Representation Issues: Representations and Mappings - Approaches to KR - Issues in KR - The Frame Problem. **Using Predicate Logic:** Representing Simple Facts in Logic - Representing Instances and ISA Relationships - Computable Functions and Predicates - Resolutions - Natural Deductions. R**epresenting Knowledge using Rules:** Procedural versus Declarative Knowledge - Logic Programming - Forward Versus Backward Reasoning - Matching - Control Knowledge. **Statistical Reasoning:** Probability and Bayes Theorem - Certainty Factors and Rule based Systems - Bayesian Networks - Dempsters Shafer Theory - Fuzzy Logic.

UNIT III: Learning **(12 Hours)**

Learning: Meaning of Learning - Rote Learning - Learning by Taking Advice - Learning by Problem Solving - Learning from Examples: Induction - Explanation based Learning - Discovery - Analogy - Formal Learning Theory - Neural Net Learning and Genetic Learning. **Parallel and Distributed AI:** Psychological Modeling - Parallelism in Reasoning Systems - Distributed Reasoning Systems.

UNIT IV: AI Methodologies **(12 Hours)**

Deep Learning Frameworks and AI Methodologies: Working - Framework - programmingLanguages - applications - optimization - fuzzy inference systems - artificial creativity - additional AI methodologies - glimpse into the future. **Building DL network using MXNet, TensorFlow and Keras:** Core components - MXNet, TensorFlow and Keras in action - Summary and Visualization.

UNIT V: Algorithm Implementation **(12 Hours)**

Building and optimizer based on PSO and GA: Algorithm - implementation - variants - PSO and GA in action - Framework and tips. **Building an Advanced DL system:** CNN - RNN. **Alternative AI frameworks in DS:** ELMs - CapsNets - Fuzzy logic and Fuzzy inference systems.

Teaching Methodology	Videos, PPT, Blackboard, Demonstration, Exercises

Book for Study

1. Kevin Night. (2008). *Artificial Intelligence (SIE)*. McGraw Hill.

Books for Reference

1. Russell. (2016). *Artificial intelligence: a modern approach*. Pearson Education Limited.
2. Bratko, I. (2011). *Prolog Programming for Artificial Intelligence* (4th ed.). Addison-Wesley Educational Publishers.

Websites and eLearning Sources

1. http://www.aispace.org/index.html
2. https://www.britannica.com/technology/artificial-intelligence

3. https://www.sas.com/en_in/insights/analytics/what-is-artificial-intelligence.html

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of Artificial Intelligence	**K1**
CO2	interpret the uses of search techniques	**K2**
CO3	apply the different knowledge representation techniques	**K3**
CO4	analyse the various learning methods	**K4**
CO5	determine the AI methodologies	**K5**
CO6	discuss the implementation of algorithm	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**23PDS3CC07**	**Core Course - 7:** Artificial Intelligence and Data Science								**4**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcome (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	3	3	3	2	2	2	**2.5**
CO2	3	2	2	2	2	3	3	3	3	3	**2.6**
CO3	2	3	3	3	2	2	2	2	2	2	**2.3**
CO4	3	2	2	3	3	2	2	3	3	2	**2.5**
CO5	3	3	2	2	2	3	3	3	2	3	**2.6**
CO6	2	3	3	3	2	2	3	2	2	2	**2.4**
										Overall Mean Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CC08	**Core Course - 8:** Core Industry Module: Business Analytics	4	4

Course Objectives
To develop a comprehensive understanding of the business analytics process and its applications in decision-making
To cultivate effective critical thinking and questioning skills essential for data science inquiries and statistical inference
To explore advanced analytics through real-world case studies
To apply analytical techniques to solve practical business problems
To analyse and interpret data in various business domains through in-depth case studies

UNIT I: Business Analytics **(12 Hours)**

Introduction to Business Analytics - Business Analytics Process - Identifying Data - Types and Stages of Data Analytics with an Example for Each Business Intelligence and Data Engineering - Exploratory Data Analytics - Communicating Business Analytics Results

UNIT II: Asking Data Science Questions **(12 Hours)**

Asking Data Science Questions - Good Question - Critical Thinking - Reasoning - Weak Sense Critical Thinking and Strong Sense Critical Thinking - Question Meetings - Question Types - Key areas of Questioning - Challenging Evidence - Statistical Inference.

UNIT III: Advanced Analytics: Exploring Strategies and Applications **(12 Hours)**

Introduction to advanced analytics - Workflow - Case Studies - Prescriptive Analytics: Introduction - Prescriptive Analytics Workflow - Case Studies - Experimental Analytics: Introduction - Workflow and Case Studies

UNIT IV: Applied Analytics: Exploring What-If Analysis, Optimization, and Business Scenarios **(12 Hours)**

Case Studies - Examples and Problems on What if Analysis - Goal Seek - Solvers for Optimization - Linear and non-linear mixture problems - Importance of Creating and Evaluating Business Scenarios.

UNIT V: Applied Business Analytics **(12 Hours)**

Case Studies on Customer Analytics - Marketing Performance Measurement and Management - Employee Performance Analytics - Operation Analytics - Accounting Analytics.

Teaching Methodology	Lectures and Presentations, Interactive Discussions, Case Studies, Collaborative Learning

Books for Study

1. Pochiraju, B., & Seshadri. S. (2019). *Essentials of Business Analytics*. (1st ed.). Springer.
2. Bag, D. (2016). *Business Analytics*. (1st ed.). Routledge.
3. Marc, J.S. Schniederjans., Schniederjans, D.G., & Starkey, C.M. (2022). *Business Analytics Principles, Concepts, and Applications: What, Why, and How*. (1st ed.). Pearson Education.
4. Stephenson, D. (2018). *Big Data Demystified: How to use big data, data science and AI to make better business decisions and gain competitive advantage.* (1st ed.). FT Publishing International.

Books for Reference

1. Marr, B. (2017). *Data Strategy: How to Profit from a World of Big Data, Analytics and the Internet of Things*. Kogan Page Publishers
2. Hardoon, Roi, D., Shmueli, G. (2015). *Getting started with business analytics: insightful decision-making*. CRC Press.

Websites and eLearning Sources

1. https://www.tutorialspoint.com/business_analysis/index.htm
2. https://www.simplilearn.com/tutorials/business-analysis-tutorial
3. https://online.hbs.edu/blog/post/prescriptive-analytics

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the fundamental components and stages of the business Analytics process and their applications	**K1**
CO2	explain the critical thinking skills necessary for effective data Science questioning and apply them to analyse and critique Evidence	**K2**
CO3	make use of advanced analytics strategies to address real-world Business challenges	**K3**
CO4	examine various analytical techniques to formulate data-driven Solutions for complex business scenarios.	**K4**
CO5	assess case studies to make informed judgments and recommendations	**K5**
CO6	construct comprehensive business analytics plans and solutions	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23PDS3CC08**		**Core Course - 8:** Core Industry Module: Business Analytics						**4**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	1	3	3	3	2	1	**2.4**
CO2	2	2	3	2	2	2	2	3	2	2	**2.2**
CO3	3	2	3	2	2	3	2	3	2	2	**2.4**
CO4	3	2	2	2	2	3	2	2	2	2	**2.2**
CO5	2	3	3	2	1	2	3	3	2	1	**2.2**
CO6	2	3	3	2	1	2	3	3	2	1	**2.2**
										Overall Mean Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CC09	**Core Course - 9:** Research Methodology	5	4

Course Objectives
To develop a fundamental understanding of research methodologies and their applications in academic and professional contexts
To equip students with the skills necessary to plan, execute, and evaluate a research project, adhering to ethical and quality standards
To enhance critical reading and analytical capabilities
To enable students to design and conduct experiments, interpret statistical results, and draw valid conclusions from data analysis
To cultivate proficiency in presenting research findings through effective writing and visual representation

UNIT I: Introduction to Research **(15 Hours)**

Meaning, Objectives and Characteristics of research - Research Methods Vs. Methodology - Types of research- Research process - Criteria of good research - Research Project: Shaping a Research Project - Research Planning - Students and Advisors - Checklist.

Unit II: Literature Review **(15 Hours)**

Reading and Reviewing - Hypotheses, Questions, and Evidence.

Unit III: Experiments for Computing **(15 Hours)**

Experimentation-Statistical Principles-Writing a Paper: Organization - Good Style - Style Specifics - Punctuation - Mathematics - Algorithms - Graphs, Figures, and Tables - Other Professional Writing.

Unit IV: Presentation **(15 Hours)**

Editing - Presentations - Slides - Posters - Ethics.

Unit V: Report writing **(15 Hours)**

Report writing using LATEX for a research problem.

Teaching Methodology	Lectures and Discussions, Case Studies and Real-life Examples, Group Projects and Collaborative Learning

Books for Study:

1. Kothari C. R. (2004). Research Methodology Methods and Techniques. (2nd ed.). New Age International Publishers.
2. Zobel, J. (2014). Writing for Computer Science. (3rd ed.). Springer-Verlag.

Books for Reference:

1. Kumar, R. (2011). Research Methodology -a step-by-step guide for beginners. (3rd ed.). SAGE Publications India Pvt Ltd.
2. Panneerselvam, R. (2014). Research Methodology. (2nd ed.). New Delhi: Prentice Hall.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the fundamental principles and characteristics of research methodologies	**K1**
CO2	interpret the process of shaping a research project and demonstrate comprehension of various types of research	**K2**
CO3	apply critical reading and analytical skills to conduct effective literature reviews and evidence synthesis for research	**K3**
CO4	analyze the statistical principles and experimental data, integrating them to draw valid conclusions and insights	**K4**
CO5	evaluate and assess research papers, projects, and presentations for their structure, style, and content quality	**K5**
CO6	create well-structured research reports using LATEX, integrating research methodologies and adhering to ethical guidelines	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23PDS3CC09**		**Core Course - 9:** Research Methodology						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	3	2	2	2	**2.4**
CO2	3	3	2	2	2	3	3	2	2	2	**2.4**
CO3	3	3	2	2	2	3	3	3	2	2	**2.5**
CO4	3	3	2	2	2	3	3	3	2	2	**2.5**
CO5	3	3	2	2	2	3	2	2	2	2	**2.3**
CO6	3	3	2	2	2	3	2	2	2	2	**2.3**
										Overall Mean Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CP03	**Core Practical - 3:** Machine Learning	4	3

Course Objectives
To acquire skills in data manipulation and analysis using NumPy and Pandas
To gain proficiency in data visualization through graph creation and interpretation
To explore dimensionality reduction techniques, encompassing both supervised and unsupervised methods
To develop the ability to construct and apply classification models, including SVMs, kernel SVMs, logistic regression, and decision trees
To utilize unsupervised learning for data clustering, employing methods such as k-means and DBSCAN

List of Exercises

1. Programs using NumPy and Pandas
2. Visualizing using graphs
3. Supervised data compression via linear discriminant analysis
4. Unsupervised dimensionality reduction via principal component analysis
5. Classification with support vector machines (SVM)
6. Modeling class probabilities via logistic regression.
7. Solving Classification problem using Decision tree
8. Supervised data compression via linear discriminant analysis
9. Grouping objects by similarity using k-means
10. Organizing clusters as a hierarchical tree

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	define and explain the different types of machine learning models	**K1**
CO2	identify machine learning algorithms employed in addressing diverse problems, including classification, regression, and clustering	**K2**
CO3	explain appropriate metrics to evaluate machine learning modelperformance	**K3**
CO4	analyze the outcomes of machine learning projects to identifypatterns and trends	**K4**
CO5	evaluate and troubleshoot issues in machine learning models toimprove their performance	**K5**
CO6	design and implement machine learning models that can bedeployed across various environments	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PDS3CP03**			**Core Practical - 3:** Machine Learning					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	3	3	2	2	2	1	3	**2.2**
CO2	2	3	2	2	2	2	2	3	2	2	**2.2**
CO3	3	3	3	2	2	3	3	2	3	2	**2.6**
CO4	2	3	3	2	2	3	2	2	3	2	**2.4**
CO5	3	3	2	2	3	2	2	3	1	2	**2.3**
CO6	3	2	2	1	2	3	3	2	3	3	**2.4**
Overall Mean Score											**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3CP04	**Core Practical - 4:** Artificial Intelligence	4	3

Course Objectives
To develop knowledge and understand the fundamental concepts of AI
To enhance the uses of searching algorithms
To enable the learning through gaming
To enrich a proper understanding of the various problems related to AI
To deploy problem solving skills through AI

List of Exercises

1. Program to Implement Breadth First Search using Python.
2. Program to Implement Depth First Search using Python.
3. Program to Implement Tic-Tac-Toe game using Python.
4. Program to Implement 8-Puzzle problem using Python.
5. Program to Implement Water-Jug problem using Python.
6. Program to Implement Travelling Salesman Problem using Python.
7. Program to Implement Tower of Hanoi using Python.
8. Program to Implement Monkey Banana Problem using Python.
9. Program to Implement Alpha-Beta Pruning using Python.
10. Program to Implement 8-Queens Problem using Python.

Teaching Methodology	Hands-on Programming Exercises and Labs, Project Work

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of Artificial Intelligence	**K1**
CO2	interpret the various searching algorithms	**K2**
CO3	apply the different problem-solving techniques	**K3**
CO4	analyse the usages of gaming problem	**K4**
CO5	determine the pruning problem	**K5**
CO6	discuss the various types of AI problem solving techniques	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**23PDS3CP04**			**Core Practical - 4:** ArtificialIntelligence					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	2	2	2	2	2	2	**2.2**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.2**
CO6	3	3	2	2	2	2	2	2	2	2	**2.2**
										Overall Mean Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PDS3IS01	Internship	-	2

Course Objectives
To develop critical thinking skills
To enhance creativity and innovation
To strengthen communication and teamwork skills
To cultivate ethical awareness and responsibility
To foster effective collaboration

Internship		
SL	**Area of Work**	**Maximum Marks**
1	**First Review** Plan of the Internship, Problem definition, Technology Adopted	**25**
2	**Second Review** Execution of the plan / Collection of data / Organization of Materials / Fabrication Experimental study / Hypothesis, Testingetc., and Presentation	**25**
3	Documentation	**25**
4	Viva Voce Examination	**25**
	TOTAL	**100**

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - level)**
CO1	Apply theoretical knowledge gained in the classroom to practical,real-world situations.	**K1**
CO2	Exhibit professional growth by adapting to diverse work	**K2**
CO3	Enhance communication skills, including written, verbal, andinterpersonal communication.	**K3**
CO4	Develop problem-solving and critical thinking skills to addressreal-world challenges.	**K4**
CO5	Build a professional network within the industry or field of interest.	**K5**
CO6	Demonstrate ethical awareness and responsible work practices.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
3	**23PDS3IS01**		**Internship**						**-**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores Of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	3	3	3	3	2	3	2	3	**2.6**
CO2	3	2	2	3	2	2	2	2	3	2	**2.3**
CO3	3	3	3	3	3	2	3	2	3	2	**2.7**
CO4	2	3	2	2	2	2	2	3	2	3	**2.3**
CO5	3	2	1	1	2	3	2	3	2	3	**2.2**
CO6	3	3	3	3	3	2	3	2	3	2	**2.7**
										Overall Mean Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PDS4CC10	**Core Course - 10:** Cloud Computing	5	5

Course Objectives
To develop knowledge and understand the fundamental concepts cloud computing
To enhance the cloud virtualization
To enable the use of cloud in various fields
To enrich a proper understanding of cloud security and privacy
To deploy the various cloud technologies

UNIT I: Basics of Cloud Computing **(15 Hours)**

Introduction to Cloud Computing: Introduction - History - Fundamentals of Cloud computing - characteristics - Advantages and Disadvantages- Comparison of traditional and cloud computing paradigms- Evaluating the impact and economics - Business drivers- Future of cloud. **Services and Deployment model:** Cloud deployment models - Cloud service models - Cloud infrastructure mechanisms - Cloud service management

UNIT II: Cloud Architecture **(15 Hours)**

Cloud Computing Architecture: Cloud computing architecture - Design principle - Life cycle (CCLC) -Reference architecture - Load balancing approach - Mobile cloud computing (MCC) - Casestudy of oracle cloud management. **Virtualization:** Understanding - Adoption - Techniques - Working of Virtualization - Kernel-based virtual machine (KVM) - VMware - VirtualBox - Citrix - Types of virtualizations - Virtualization in cloud

UNIT III: Cloud Applications **(15 Hours)**

Service Oriented Architecture: Objectives - SOA foundation - Web services and SOA - SOA communication - SOA components - SOA Infrastructure - Need of SOA - Business Process Management (BPM) - Services of BPM. **Cloud Computing Applications:** Introduction - Google App Engine - Google Apps - Google Cloud Data store - Dropbox Cloud - Apple iCloud - Microsoft Windows Azure Cloud - Amazon Web Services (AWS)

UNIT IV: Cloud Security and Privacy **(15 Hours)**

Cloud Security - Cloud CIA security model - Cloud computing security Architecture - Service provider security issues - Security issues in Virtualization - Data security in cloud - Data privacy risks - Business continuity and disaster recovery - Threats in cloud - Security techniques for threats. **Cloud service level agreements (SLA):** Components - Types - Cloud vendors - Quality of Cloud Services - Techniques - Migration - Trust management.

UNIT V: Cloud Technologies **(15 Hours)**

Cloud Computing Technologies - High performance Computing - Message Passing Interface (MPI) - MapReduce programming model -Dryad and Dryad LINQ -Eucalyptus cloud platform: Components - Open Nebula: Layers - Features - OpenStack: components - Benefits - The Apache Hadoop ecosystem. **Adoption of Cloud Computing:** Factors affecting the adoption - Existing areas of application - Case studies -Certifications.

Teaching Methodology	Videos, PPT, Case Studies, Group Project.

Book for Study

1. Hiran, K. (2019). *Cloud Computing: Master the Concepts, Architecture and Applications with Real-world examples and Case studies*. BPB Publishers.

Books for Reference

1. Motwani, B. (2020). *Data Analytics using Python*. Wiley.
2. Piper, B. (2019). *AWS Certified Solutions Architect Study Guide: Associate SAA-C01 Exam*. Googel Book.
3. Rajan, L. (2019). *Building Google Cloud Platform Solutions: Develop Scalable Applications from Scratch and Make Them Globally Available in Almost Any Language.* Packt.

4. Buyya, R. (2013). *Mastering Cloud Computing*. Tata McGraw Hill Education Pvt ltd

Websites and eLearning Sources

1. https://acloudguru.com
2. https://www.cloudcomputing-news.net/
3. https://cloudtweaks.com/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the basic concepts of cloud	**K1**
CO2	interpret the cloud architecture	**K2**
CO3	apply the service-oriented architecture	**K3**
CO4	analyze the various applications of cloud	**K4**
CO5	determine the cloud security and privacy	**K5**
CO6	discuss the various types of cloud technologies	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PDS4CC10**			**Core Course - 10:** Cloud Computing					**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSO)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	3	3	3	2	3	**2.7**
CO2	2	3	2	2	3	2	3	2	2	2	**2.3**
CO3	3	3	2	2	3	2	2	3	2	2	**2.3**
CO4	2	2	2	3	2	3	2	2	2	3	**2.3**
CO5	3	3	2	2	1	1	2	3	2	3	**2.1**
CO6	3	3	2	2	2	2	2	2	2	2	**2.1**
										Overall Mean Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PDS4ES04A	**Elective - 4:** Deep Learning	5	4

Course Objectives
To acquire fundamental knowledge about neural networks and how they compare to biological neurons
To achieve a clear understanding of shallow neural networks, including perceptrons and backpropagation networks
To explore the mechanics of convolutional neural networks (CNNs) and recognize their diverse applications
To delve into recurrent neural networks (RNNs) and their practical implementations across various domains
To explain how auto encoders can be used to solve machine learning problems

UNIT I: Introduction to Artificial Neural Networks **(15 Hours)**

Neural Networks - Application Scope of Neural Networks - Fundamental Concept of ANN: The Artificial Neural Network - Biological Neural Network - Comparison between Biological Neuron and Artificial Neuron - Evolution of Neural Network. Basic models of ANN - Learning Methods - Activation Functions - Importance Terminologies of ANN.

UNIT II: Supervised Learning Network **(15 Hours)**

Shallow neural networks - Perceptron Networks - Theory - Perceptron Learning Rule Architecture - Flowchart for training Process - Perceptron Training Algorithm for Single and Multiple Output Classes. Back Propagation Network - Theory - Architecture - Flowchart for training process -Training Algorithm - Learning Factors for Back - Propagation Network. Radial Basis Function Network RBFN: Theory, Architecture, Flowchart and Algorithm.

UNIT III: Convolutional Neural Network **(15 Hours)**

Introduction - Components of CNN Architecture - Rectified Linear UNIT (ReLU) Layer - Exponential Linear UNIT (ELU, or SELU) - Unique Properties of CNN -Architectures of CNN - Applications of CNN.

UNIT IV: Recurrent Neural Network **(15 Hours)**

Introduction - The Architecture of Recurrent Neural Network - The Challenges of Training Recurrent Networks - Echo-State Networks - Long Short - Term Memory (LSTM) - Applications of RNN

UNIT V: Auto Encoder and Restricted Boltzmann Machine **(15 Hours)**

Introduction - Features of Auto encoder Types of Autoencoder Restricted Boltzmann Machine- Boltzmann Machine - RBM Architecture -Example - Types of RBM.

Teaching Methodology	Lecture-based Learning, Discovery Learning, Expeditionary learning

Books for Study

1. Sivanandam, S.N., & S Deepa, S.N. (2018). *Principles of Soft Computing.* (3rd ed.). Wiley Publication.
2. Rose, S.L., Kumar, A.L., & Renuka, D.K. (2019). *Deep Learning using Python.* (1st ed.). Wiley Publication.

Books for Reference

1. Aggarwal, C.C. (2018). *Neural Networks and Deep Learning.* Springer Publication.
2. Chollet, F. (2017). *Deep Learning with Python.* (1st ed.). Manning Publications.
3. Kelleher, J.D. (2019). *Deep Learning.* MIT Press.

Websites and eLearning Source

1. https://onlinecourses.nptel.ac.in/noc22_cs22/previe
2. whttps://arxiv.org/abs/1506.06579
3. https://arxiv.org/abs/1605.06211
4. https://cs230.stanford.edu/lecture/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the key concepts of Neural Networks	**K1**
CO2	explain the Perceptron Learning Rule, Back Propagation	**K2**
CO3	apply CNN architectures for specific image processing tasks	**K3**
CO4	analyse Echo-State Networks and LSTM in sequence Modeling tasks	**K4**
CO5	evaluate the effectiveness of Auto encoders and rbms in featureextraction	**K5**
CO6	create flowcharts for the training processes of all the networks	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
4	**23PDS4ES04A**			**Elective - 4:** Deep Learning						**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	1	2	3	1	2	2	1	3	**2**
CO2	3	2	3	2	2	3	2	3	1	3	**2.4**
CO3	2	1	3	2	1	1	3	2	1	3	**1.9**
CO4	3	2	3	3	3	1	3	3	2	1	**2.4**
CO5	3	2	3	3	3	2	2	3	2	3	**2.6**
CO6	3	2	3	2	1	2	2	2	3	3	**2.3**
									Overall Mean Score		**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PDS4ES04B	**Elective - 4:** Image Recognition	5	4

Course Objectives
To learn how human vision works and how it relates to computer vision
To use image processing techniques to solve real-world computer vision problems
To apply geometric transformations to align and manipulate images
To create and use algorithms to find and describe image features for object recognition
To assess and compare different object recognition methods

UNIT I: Computer Vision and Image Fundamentals **(15 Hours)**

Introduction: The Human Vision System - Practical Applications of Computer Vision - The Futureof Computer Vision. **Images:** The Simple Pinhole Camera Model - Images - Sampling- Quantization- Color Images- Noise - Smoothing

UNIT II: Histograms and Binary Vision Techniques **(15 Hours)**

Histograms:1D Histograms - Histogram/Image Equalization- Histogram Comparison-k-means Clustering. **Binary Vision:** Thresholding- Threshold Detection Methods- Mathematical Morphology.

UNIT III: Geometric Transformation and Edge Detection **(15 Hours)**

Geometric Transformation: Affine Transformations - Perspective Transformations - Interpolation. **Edges:** Edge Detection - Contour Segmentation - Hough Transform

UNIT IV: Feature Detection **(15 Hours)**

Features: Moravec Corner Detection - Harris Corner Detection - FAST Corner Detection- SIFT - Recognition

UNIT V: Recognition Techniques and Computer Vision Problems **(15 Hours)**

Recognition: Template Matching - Chamfer Matching - Statistical Pattern Recognition - Cascadeof Haar Classifiers - Other Recognition Techniques - Performance. **Vision Problems:** Abandoned and Removed Object Detection - Traffic Lights - Real Time Face Tracking - Road Sign Recognition - License Plates

Teaching Methodology	Lecture-based Learning, Expeditionary Learning

Books for Study

1. Dawson, K. (2014). *A Practical Introduction to Computer Vision with OpenCV*. John Wiley& Sons Ltd.

Books for Reference

1. Forsyt, A.D., Ponce, J. (2015). *Computer Vision: A Modern Approach*. PearsonPublication.
2. Solem, J.E. (2012). *Programming Computer Vision with Python: Tools and Algorithms for Analyzing* Images. O'Reilly Media Publication.
3. Szeliski, R. (2011). *Computer Vision: Algorithms and Applications*. Springer Publications.
4. Prince, S.J.D. (2012). *Computer Vision: Models, Learning, and Inference*. Cambridge University Press.

Websites and eLearning Source

1. https://www.cs.toronto.edu/~urtasun/courses/CV/lecture01.pdf
2. https://www.cl.cam.ac.uk/teaching/0809/CompVision/CompVisNotes.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the fundamental concepts of the Human Vision System andthe basics of Computer Vision	**K1**
CO2	identify how binary vision works, including Thresholding, Threshold Detection Methods, and Mathematical Morphology	**K2**
CO3	apply Affine and Perspective Transformations in imageprocessing tasks and implement edge detection techniques	**K3**
CO4	analyze the strengths and weaknesses of different recognition Techniques	**K4**
CO5	evaluate the performance of computer vision systems in real-world scenarios	**K5**
CO6	create customized computer vision solutions by combining multiple recognition techniques to address vision problems	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PDS4ES04B**			**Elective - 4:** Image Recognition					**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	3	2	2	3	2	3	**2.5**
CO2	3	2	3	2	2	2	2	2	3	2	**2.3**
CO3	3	2	2	2	2	3	3	2	3	2	**2.4**
CO4	3	2	2	2	2	3	2	2	3	2	**2.3**
CO5	3	2	3	2	3	2	2	2	3	2	**2.4**
CO6	2	1	2	1	2	3	3	1	2	3	**2**
										Overall Mean Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours	Credits
4	23PDS4PW01	Project Work & Viva Voce	20	17

Course Objectives
To develop critical thinking skills through the analysis and evaluation of problems and solutions
To enhance creativity and innovation by designing and developing new solutions
To strengthen communication and teamwork skills by effectively collaborating with others on projects
To cultivate ethical awareness and responsibility by considering the ethical implications of technologies
To collaborate with both teams and work independently to pursue a common goal

Project Work		
SL	**Area of Work**	**Maximum Marks**
1	**PROJECT WORK**: (i) Plan of the Project	**40**
	(ii) Execution of the plan / Collection of data / Organization of Materials / Fabrication Experimental study / Hypothesis, Testingetc. and Presentation of the report.	**90**
	(iii) Individual Initiative	**20**
2	Viva Voce Examination	**50**
TOTAL		**200**

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - level)**
CO1	Show leadership skills and learn time management	**K1**
CO2	Identify various tools to be applied to a specific problem	**K2**
CO3	Evaluate the reports	**K3**
CO4	Take part in a team as well as manage it to deliver stunning outcomes	**K4**
CO5	Apply the appropriate techniques, skills, and tools to solve a real-world problem.	**K5**
CO6	Develop the individual skills to present and organize projects	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
4	**23PDS4PW01**			Project work & Viva Voce					**20**		**17**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score Of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	3	2	3	2	3	2	**2.5**
CO2	2	2	1	3	3	1	2	3	3	2	**2.2**
CO3	1	3	1	3	3	3	3	2	3	3	**2.5**
CO4	3	2	3	3	3	3	3	2	3	2	**2.7**
CO5	2	2	3	3	2	1	1	3	2	3	**2.2**
CO6	3	1	3	3	2	3	2	2	1	3	**2.3**
										Overall Mean Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours	Credits
4	23PDS4CE01	Comprehensive Examination	-	2

Course Objectives
To develop students' understanding of the fundamental concepts of data science
To provide students with the skills and knowledge necessary to solve real-world data science problems
To expose students to a variety of data science tools and platforms
To develop students' critical thinking and problem-solving skills
To prepare students for careers in data science

UNIT I: Statistical Analysis and Linear Algebra

Correlation: Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only). **Vectors and Matrices:** Vectors and Linear Combinations-Lengths and Angles from Dot Products- Matrices and Their Column Spaces. **Solving Linear Equations Ax = b:** Elimination and Back Substitution-Elimination Matrices and Inverse Matrices-Matrix Computations and A = LU-Permutations and Transposes. **The Four Fundamental Subspaces:** Vector Spaces and Subspaces-Computing the Nullspace by Elimination: A = CR-The Complete Solution to Ax = b-Independence, Basis, and Dimension- Dimensions of the Four Subspaces.

UNIT II: Data Science Fundamentals and Data Structures

Data Science - Data science Venn diagram - Basic terminology - Data science case studies- Types of data - Types of data analytics - Data warehousing - Design consideration of data warehouse - Data loading process - Data mining - Data mining techniques - Tools and platforms. **Basic concepts of Data Structure:** Problem Solving techniques - List ADT - Stacks ADT - Queue ADT - Preliminaries Binary Tree - Binary Search Trees - AVL Trees - B-Trees. Sorting: Preliminaries, Insertion Sort, Shell Sort, Heap Sort, Merge Sort, Quick Sort, External Sorting.

UNIT III: Machine Learning and Artificial Intelligence

Giving Computers the ability to learn from data - Introduction - Building intelligent systems to transform data into knowledge - The three different types of Machine Learning (ML) - Introduction to basic terminology and notations - A roadmap for building ML systems. **Data Preprocessing:** Missing data - Categorical data - Partitioning a dataset into separate training and test datasets - Bringing features onto the same scale - Selecting meaningful features - Assessing feature importance with random forests. **Artificial Intelligence:** The AI Problems - The Underlying Assumptions - AI Technique - The Level of the Model - Criteria for Success. **Problems, Problem Spaces & Search:** Defining the problem as a State Space Search - Production systems - Problem Characteristics - Production Systems Characteristics - Issues in the Design of Search Programs. **Heuristic Search Techniques:**Generate and Test - Hill Climbing - Best First Search - Problem Reduction - Constraint Satisfaction - Means ends Analysis.

UNIT IV: Software Testing and Applied Business Analytics

Software Testing: Component Level: A Strategic Approach to Software Testing - Planning and Recordkeeping - Test-Case Design - White-box Testing - Black-Box Testing - Object-oriented Testing. Software Testing - Integration Level: Software Testing Fundamentals - Integration Testing - Artificial Intelligence and Regression Testing - Integration Testing in the OO context - Validation Testing - Testing Patterns.**Applied Business Analytics**: Case Studies on Customer Analytics, Marketing Performance Measurement and Management, Employee Performance Analytics, Operation Analytics, Accounting Analytics.

UNIT V: Python Programming

Basics of Python: Input - Output - Identifiers - Variables, Assignment Statements and Expressions - Named Constants - Numeric Data Types and Operators - Evaluating Expressions and Operator Precedence - Common Python Functions - Control Structures and Loops - Objects and Classes - Inheritance and Polymorphism - Exception Handling.

Teaching Methodology	Active Learning, Self-Learning

Books for Study

1. Ross, S.M. (2023). *Introduction to Probability and Statistics for Engineers and Scientists* (5th Ed.), Elsevier Academic Press.
2. Strang, G. (2023). *Introduction to Linear Algebra.* (6th Ed.). Cambridge Press.
3. Sinan, O. (2016). *Principles of Data Science*. Packt Publishing.
4. Aho, J. E. H., & Ullman, J.D. (2009). *Design and Analysis of Computer Algorithms* (1st Ed.). Addison-Wesley. Massachusetts.
5. Raschka, S., & Mirjalili, V. (2019). *Python Machine Learning*. (3rd ed.). Packt publishing.
6. Night, K. (2008). *Artificial Intelligence (SIE)*. McGraw Hill.
7. Pressman, R. S., & Maxim, B.R. (2020). *Software Engineering: A Practitioner'sApproach.* (9th ed.). McGraw Hill.
8. Stephenson, D. (2018). *Big Data Demystified: How to use big data, data science and AI to make better business decisions and gain competitive advantage*. (1st ed.). F T Publishing International.
9. Lang, Y.D. (2013). *Introduction to Programming using Python* (2nd ed.). PearsonEducation.

Books for Reference

1. Goodrich, M. T., Tamassia, R., & Mount, D. M. (2023). *Data structures and algorithms in Python: Fundamentals to advanced* (3rd ed.). Addison-Wesley Professional.
2. Axler, S. (2015). *Linear Algebra Done Right (Undergraduate Texts in Mathematics)*. (3rded.). Springer.
3. Jean, H. Education, C. (2023). *Data Science*. Certy box Education.
4. Pressman, R. S., & Maxim, B.R. (2020). Software Engineering: A Practitioner's Approach (9th ed.). McGraw Hill.
5. Goodrich, M. T. Tamassia, R., & Mount, D. M. (2023). *Data structures and algorithms in Python: Fundamentals to advanced.* (3rd ed.). Addison-Wesley Professional.
6. Raschka, S., & Mirjalili, V. (2022). *Machine learning with Python: A comprehensive guide* (3rd ed.). Packt Publishing.
7. Russell, S. J., & Norvig, P. (2021). *Artificial intelligence: A modern approach* (4th ed.). Pearson.
8. Martin, R. C. (2002). Agile software development: principles, patterns, and practices. Prentice Hall.
9. Hollingworth, K. (2023). *Dead simple Python: Idiomatic Python for the impatient programmer*. Manning Publications.

Websites and eLearning Source

1. https://www.w3schools.com/ai/
2. https://www.simplilearn.com/tutorials/statistics-3.tutorial
3. https://www.python.org/
4. https://www.guru99.com/agile-testing-course.html

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall the concepts of correlation, scatter plots, vectors, andmatrices	**K1**
CO2	explain data warehousing principles and data mining techniques	**K2**
CO3	develop test cases and perform integration testing	**K3**
CO4	analyze the challenges and assumptions in AI problem-solving	**K4**
CO5	evaluate the suitability of Python for various programming tasks	**K5**
CO6	design enhanced decision-making methodologies for diverse industrial applications	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
4	**23PDS4CE01**			Comprehensive Examination						**-**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	3	3	3	3	2	3	3	**2.6**
CO2	3	3	3	1	2	2	2	2	3	1	**2.2**
CO3	3	2	1	2	2	3	2	1	1	3	**2**
CO4	2	2	3	3	3	1	2	3	3	3	**2.5**
CO5	3	3	2	2	3	3	3	2	2	2	**2.5**
CO6	2	2	3	2	1	2	2	2	3	3	**2.2**
Overall Mean Score											**2.3 (High)**