M Sc DATA SCIENCE

LOCF SYLLABUS 2025

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 92 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.*

Discipline Specific 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.*

Research Methodology (RM)*: It is a two-credit course offered in the third designed to cultivate a strong research aptitude among postgraduate students. The course equips learners with essential skills for formulating research problems and pursuing impactful research.*

Open Elective Courses (OE): *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 Open elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AEC): *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 (SEC): *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-Learning (SL): *A two-credit course designed to foster students' ability for independent and self-directed learning. There are* Three Self-Learning Courses:

- 'Global Citizenship Education' *a common online course offered to all PG students in Semester I on JosTEL.*
- *Compulsory MOOC on NPTEL-SWAYAM in Semester I or II*
- *A Department-Specific Self-Learning Course in Semester III on JosTEL*

Comprehensive Examination (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 three semesters (1 - 4). 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:

25	**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 - Discipline Specific Elective
AE - Ability Enhancement Course
SL - Self-Learning
OE – Open Elective
PW - Project and Viva Voce
CE - Comprehensive Examination
OR - Outreach Programme
IS – Internship

EVALUATION PATTERN (PG)
Continuous Internal Assessment

Sl No	Component	Marks Allotted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Two Components (15 + 20)	35
4	Library Referencing	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) for 15 marks comprising 7 questions (1 mark) at K1 level and 4 questions (2 marks) at K2 level;* The second component is decided by the course in-charge in accordance with the prescribed K levels.

Question Paper Blueprint for Mid and End Semester Tests

Duration: 2 Hours								**Maximum Marks: 60**
Section		**K levels**						**Marks**
		K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(compulsory)*		7						7 × 1 = 7
B *(compulsory)*			5					5 × 3 = 15
C *(either…or type)*				3				3 × 6 = 18
D *(2 out of 3)*	Mid Sem				1(2)	1*		2 × 10 = 20
	End Sem					1(2)	1*	
							Total	**60**

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours							**Maximum Marks: 100**
Section	**K levels**						**Marks**
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	
A *(compulsory)*	10						10 × 1 = 10
B *(compulsory)*		10					10 × 3 = 30
C *(either…or type)*			5				5 × 6 = 30
D *(3 out of 5)*				1(2)	1(2)	1*	3 × 10 = 30
						Total	**100**

***** *Compulsory*

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Final
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(Department)*	100
• Self - Learning Course (Dept. Specific) • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship • Self - Learning Course (Common) • Self - Learning Online Course (NPTEL / SWAYAM)	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 Outcomes (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.

M. Sc. Data Science				
Programme Structure				
Semester	**Specification**	**No. of Courses**	**Hours**	**Credits**
1 – 4	Core Course	10	49	36
1 - 4	Core Practical	5	20	13
1, 3 & 4	Discipline Specific Elective	3	12	9
1 – 2	Open Elective	2	8	4
1	Ability Enhancement Course	1	2	1
1 – 3	Self-Learning	3	-	4
2	Skill Enhancement Course	1	4	2
2	Mini Project – 1	1	0	1
3	Research Methodology	1	4	2
3	Mini Project - 2	1	-	1
3	Internship	1	-	2
4	Project	1	21	11
4	Comprehensive Examination	1	-	2
2 – 4	Outreach Programme (SHEPHERD)	-	-	4
1 – 4	Extra Credit Course	4	-	12
	Total	**35**	**120**	**92 (12)**

M. SC. DATA SCIENCE PROGRAMME PATTERN								
Course Details						Scheme of Exams		
Sem.	Course Code	Course Type	Title of the Course	Hours	Credits	CIA	SE	Final
1	25PDS1CC01	CC Major	**Core Course - 1:** Mathematics for Data Science	6	5	100	100	100
	25PDS1CC02		**Core Course - 2:** Statistics – I	6	5	100	100	100
	25PDS1CC03		**Core Course - 3:** Python Programming	4	3	100	100	100
	25PDS1CP01		**Core Practical - 1:** Python Programming Lab	4	3	100	100	100
	25PDS1ES01A	DSE	**Discipline Specific Elective - 1:** Data Structures and Algorithms	4	3	100	100	100
	25PDS1ES01B		**Discipline Specific Elective - 1:** Internet of Things					
	25PDS1AE01	AEC	**Ability Enhancement Course:** Data Analytics using Excel	2	1	100	-	100
	25PDS1OE01	OE	**Open Elective - 1 (WS):** SQL and NoSQL for Data Science	4 (2+2)	2	100	100	100
	25PGC1SL01	SL	Global Citizenship Education (Online)	0	1	100	-	100
			Extra Credit Courses	0	(3)			
			Total	**30**	**23 (3)**			
2	25PDS2CC04	CC Major	**Core Course - 4:** Statistics– II	5	4	100	100	100
	25PDS2CC05		**Core Course - 5:** Machine Learning	5	3	100	100	100
	25PDS2CC06		**Core Course- 6:** Big data Analytics	4	3	100	100	100
	25PDS2CP02		**Core Practical - 2:** Machine Learning–Lab **(Internship Embedded Course - IEC)**	4	3	100	100	100
	25PDS2CP03		**Core Practical - 3:** Big data Analytics Lab	4	3	100	100	100
	25PDS2OE02	OE	**Open Elective – 2 (BS):** Discrete Mathematics	4	2	100	100	100
	25PSS2SE01	SEC	**Skill Enhancement Course:** Soft Skills	4	2	100	-	100
	25PDS2SL02	SL	Online Courses NPTEL / SWAYAM	0	2	-	100	100
	25PDS2PW01	PW	Mini Project – 1	0	1			
			Extra Credit Course	0	(3)			
			Total	**30**	**23 (3)**			
3	25PDS3CC07	CC Major	**Core Course - 7:** Deep Learning	5	3	100	100	100
	25PDS3CC08		**Core Course - 8:** Artificial and Computational Intelligence	5	3	100	100	100
	25PDS3CC09		**Core Course - 9:** Cloud Computing (SSC / Q8302)	4 (2+2)	3	100	100	100
	25PDS3CP04		**Core Practical - 4:** Deep Learning – Lab	4	2	100	100	100
	25PDS3CP05		**Core Practical - 5:** Artificial Intelligence – Lab	4	2	100	100	100
	25PDS3ES02A	DSE	**Discipline Specific Elective - 2**: Social Media Analysis	2+2	3	100	100	100
	25PDS3ES02B		**Discipline Specific Elective - 2:** Information Retrieval					
	25PDS3RM01	RM	Research Methodology	4	2	100	100	100
	25PDS3SL03	SL	**Self - Learning:** MEAN Stack*	0	1	50	50	50
	25PDS3PW02	PW	Mini Project – 2	0	1			
	25PDS3IS01	IS	Internship	0	2	100	-	100
			Extra Credit Course	0	(3)			
			Total	**30**	**22 (3)**			
4	25PDS4CC10	CC Major	**Core Course - 10:** Data Science for Enterprises (Blended Mode)	5	4	100	100	100
	25PDS4ES03A	DSE	**Discipline Specific Elective - 3**: Business Analytics (Blended Mode)	4	3	100	100	100
	25PDS4ES03B		**Discipline Specific Elective - 3**: Health Analytics (Blended Mode)					
	25PDS4PW03	PW	Project	21	11	100	100	100
	25PDS4CE01	CE	Comprehensive Examination*	0	2	50	50	50
			Extra Credit Course	0	(3)			
			Total	**30**	**20 (3)**			
	25PCW4OR01	OR	Outreach Programme	0	4			
				120	**92 (12)**			

***For Grade Calculation:** Marks obtained out of 50 will be converted into 100 in the mark statements.

Open Elective - 1 (WS): 1st Semester

School	Course Code	Title of the Course
SCS		
Artificial Intelligence	25PAI1OE01	Neural Networks and Fuzzy Logic
Computer Science	25PCA1OE01A	AI Tools & Applications
	25PCA1OE01B	Internet of Things
Information Technology	25PCS1OE01	Big Data Analytics
Data Science	25PDS1OE01	SQL and NoSQL for Data Science
Mathematics	25PMA1OE01	Mathematical Foundations

Open Elective – 2 (BS): 2nd Semester
Offered to students from other Schools

School	Course Code	Title of the Course
SBS		
Botany	25PBO2OE02	Sustainable Horticulture and Urban Landscaping
Biochemistry	25PBI2OE02	First Aid Management
Biotechnology	25PBT2OE02	Food Technology
SCS		
Artificial Intelligence and Machine Learning	25PAI2OE02	Cyber Security
Computer Science	25PCA2OE02A	Web Design
	25PCA2OE02B	Cyber Security
Information Technology	25PCS2OE02	Recent Trends in Computing
Data Science	25PDS2OE02	Discrete Mathematics
Mathematics	25PMA2OE02	Operations Research
Visual Communication	25PVC2OE02	Women and Media
SLAC		
English	25PEN2OE02	English for Digital Media
History	25PHS2OE02	Public Administration
Tamil	25PTA2OE02	விளம்பரக்கலை (Art of advertising)
SMS		
Commerce	25PCO2OE02	Basics of Tally Prime
Commerce Computer Application	25PCC2OE02	Behavioural Dynamics and Psychology
Counselling Psychology	25PCP2OE02	Artificial Intelligence in Psychology
Economics	25PEC2OE02	Managerial Economics
Human Resource Management	25PHR2OE02	Counselling and Guidance
SPS		
Chemistry	25PCH2OE02	Chemistry of Health and Nutrition
Electronics	25PEL2OE02	Computer Hardware and Networks
Physics	25PPH2OE02A	Physics for Competitive Exams
	25PPH2OE02B	Nanoscience

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
1	25PDS1CC01	**Core Course - 1:** Mathematics for Data Science	6	5

Course Objectives
To develop a deep understanding of vectors and matrices and their applications in data science
To explore the four fundamental subspaces and their significance in solving linear systems, analysing data, and understanding the structure of matrices
To investigate the concepts of orthogonality and the role of determinants in matrix properties and solving linear equations
To gain proficiency in eigen values and eigen vectors and their importance in data science applications
To understand the concept of Singular Value Decomposition (SVD)and the behaviour of linear transformations

UNIT I: Vectors and Matrices (18 Hours)

Vectors and Linear Combinations - Lengths and Angles from Dot Products –System of Linear Equations - The Idea of Elimination- Elimination Using Matrices- Rules for Matrix Operations - Elimination = Factorization: $A = LU$- Transposes and Permutations

UNIT II: The Four Fundamental Subspaces (18 Hours)

Vector Spaces and Subspaces- Spaces of Vectors- The Nullspace of matrix A: Solving $Ax = 0$ and$Rx = 0$ - The Complete Solution to $Ax = b$- Linearly Independence, Basis, and Dimension- Dimensions of the Four Subspaces

UNIT III: Orthogonality of Vectors and subspaces (18 Hours)

Orthogonality of the Four Subspaces- Orthogonal Complement – Projections- Projections onto Lines and Subspaces - Least Squares Approximations -Fitting a Straight line- Fitting a Parabola - Orthonormal Bases and Gram-Schmidt process- Determinants – The Properties of Determinants- Permutations and Cofactor- Cramer's Rule- Areas and Volumes by Determinants

UNIT IV: Eigen values and Eigenvectors (18 Hours)

Finding Eigen values and Eigenvectors of a Matrix - their properties - Diagonalizing a Matrix – Systems of Differential Equations- Symmetric Matrices- Positive Definite Matrices

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

Singular Values- Singular Value Decomposition- The 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
Assessment Methods	MCQ, Assignment, Seminar

Books for Study:

1. Gilbert Strang. (2023). Introduction to Linear Algebra (6th ed.). Wellesley - Cambridge Press.

Books for Reference:

1. David Lay, Steven Lay and Judi McDonald. (2014). Linear Algebra and Its Applications (5th ed.). Pearsons.
2. Sheldon Axler. (2015). Linear Algebra Done Right (Undergraduate Texts in Mathematics) (3rd ed.). Springer.
3. Jim Hefferon. (2020). Linear Algebra (4th ed.). Orthogonal Publishing L3c.
4. Jeff M Philips. (2021). Mathematical Foundations for Data Analysis (1st ed.). Springer Nature Switzerland AG.

Websites and eLearning Sources:

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

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	**25PDS1CC01**	**Core Course - 1:** Mathematics for Data Science								**6**	**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	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	Credits
1	25PDS1CC02	**Core Course - 2:** Statistics – I	6	5

Course Objectives
To introduce students to the field of data science through applications of statistical concepts
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 analyze 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, populations and samples, 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.

Describing Data Sets: Frequency Tables and Graphs-Relative Frequency Tables and Graphs-Grouped Data, Ogives, and Stem and Leaf Plots.

UNIT II: Descriptive Statistics (18 Hours)

Measures of Central Tendency: Mean, Median, and Mode- Variance and Standard Deviation- Percentiles and Box Plots-Normal Data Sets-Paired Data Sets

Correlation: Scatter plot, Karl Pearson's coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

UNIT III: Basics and Elements of Probability (18 Hours)

Random experiment, sample space and events-Venn Diagrams and the Algebra of events-definition of probability- classical, empirical and axiomatic approaches to probability-properties of probability-Theorems on probability-conditional probability and independent events, law of total probability, sample spaces having equally likely outcomes, Baye's theorem and its applications.

UNIT IV: 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.

Standard discreate random variables: The Bernoulli and Binomial Random Variables-Computing the Binomial Distribution Function-The Poisson Random Variable-Computing the Poisson Distribution Function.

UNIT V: Distributions of Sampling Statistics (18 Hours)

Standard continues random variables: The Hyper geometric 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.

Distributions of Sampling Statistics: 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 $\bar{X}$ and S^2 - Sampling from a Finite Population

Teaching Methodology	Lecture, Problem solving and case studies, Collaborative learning, Interactive online sources, Visualization techniques
Assessment Methods	MCQ, Assignment, Seminar

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.
4. Gupta, S. P., (2008), Statistical Methods, (37th Ed.), Sultan Chand & Sons.

Books 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/
2. https://www.simplilearn.com/tutorials/statistics-tutorial
3. https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-dataanalysts69d93a05aae7

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, 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	**25PDS1CC02**		**Core Course - 2:** Statistics – I							**6**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**	
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 / Weeks	Credits
1	25PDS1CC03	**Core Course – 3:** Python Programming	4	3

Course Objectives
To understand data structures and OOP concepts in Python
To explore the functionalities and applications of Numpy & Pandas packages
To provide hands on training in Data Wrangling
To apply Data Aggregation and Grouping operations on real time data sets.
To exposure to Data Visualization techniques made available in Python

UNIT I: Introduction to Python (12 Hours)

Installing and using Jupyter Notebook – Creating and executing Python Programs – Variables – Data Types –Operators –Statements – Expressions – Type Conversions – Control Flow Statements – Exception Handling

UNIT II: Data Structures and Object-oriented Programming (12 Hours)

Functions – Data Structures: Lists, Dictionaries, Tuples, Sets – File handling – Regular Expressions - Object-Oriented Programming

UNIT III: NumPy Arrays and Pandas Data Frames (12 Hours)

Functional Programming: Lambda, Iterators, Generators, List Comprehensions – NumPy Arrays – Pandas Series – Pandas Data frames

UNIT IV: Operations on Pandas Data Frames (12 Hours)

Data Wrangling with Pandas – Querying Data Frames – Merging Data Frames – Applying Functions to Data Frames – Aggregations with Pandas and NumPy

UNIT V: Data Visualization (12 Hours)

Matplotlib package – Pandas. Plotting package: Scatter matrices, Lag Plots, Autocorrelation Plots, Bootstrap Plots. Seaborn Package: Stripplot, Swarmplot, Heatmap, Pairplot, Regression Plot – Formatting – Customizing Visualizations

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs
Assessment Methods	MCQ, Snap test, Assignment

Books for Study:

1. Gowrishanker and Veena, (2019), Introduction to Python Programming, CRC Press.

Books for Reference:

1. Stefanie Molin, “Data Analysis with Pandas”, Packt, 2019.
2. Joel Grus, “Data Science from scratch”, O'Reilly, 2015.
3. Wes Mc Kinney, “Python for Data Analysis”, O'Reilly Media, 2012.
4. Jake Vanderplas, “Python Data Science Handbook: Essential Tools for Working with Data “,O'Reilly Media, 2012.

Websites and eLearning Sources:

1. https://www.python.org/
2. https://www.w3schools.com/python/
3. https://www.tutorialspoint.com/python/index.htm.

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Remember Python programming concepts.	**K1**
CO2	Understand and apply the functions available in NumPy and Pandas packages.	**K2**
CO3	Apply data wrangling operations in different contexts.	**K3**
CO4	Analyze the usage of data aggregation and grouping operations.	**K4**
CO5	Evaluate and construct visuals for various real-world problems.	**K5**
CO6	Create object-oriented programming solutions for data analysis.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**25PDS1CC03**			**Core Course - 3:** 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**	**PSO 5**	
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 / Weeks	Credits
1	25PDS1CP01	**Core Practical - 1:** Python Programming Lab	4	3

Course Objectives
To understand the basic concepts of Python programming
To apply OOP concepts in Python to solve a variety of problems.
To develop solutions using the functions in Numpy and Pandas packages.
To perform data wrangling, data aggregation, and grouping operations.
To effectively build data visualizations for different contexts.

List of Exercises

1. Flow Control with Conditionals and Loops
2. Different print formats in Python
3. Functions in Python
4. String Manipulation in Python
5. Working with List, Tuples, Sets, Dictionaries
6. Object Creation and Class Usage
7. Inheritance in Object-Oriented Programming
8. Function Overloading in Python
9. Reading and Writing Text and Binary Files
10. Merging and Combining Data Sets
11. Regular Expressions in Python
12. Data Aggregation and Grouping Operations
13. Exception Handling in Python
14. Data Visualization Using Matplotlib

Data Visualization Using Seaborn

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs
Assessment Methods	Snap Test

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-levels)**
CO1	Recall basic Python concepts like data types, control structures, and syntax.	**K1**
CO2	Explain the main principles of Object-Oriented Programming (OOP) in Python.	**K2**
CO3	Apply Python libraries like NumPy and Pandas to solve data analysis problems.	**K3**
CO4	Analyze datasets to identify patterns and make inferences.	**K4**
CO5	Evaluate different data structures and algorithms for efficiency and performance.	**K5**
CO6	Create data visualizations using Matplotlib and Sea born to present results.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**25PDS1CP01**		**Core Practical - 1:** Python Programming Lab							**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 / Weeks	Credits
1	25PDS1ES01A	**Discipline Specific Elective 1:** Data Structures & Algorithms	4	3

Course Objectives
To understand fundamental concepts of Data Structures
To develop algorithms to organize the 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 and appropriate graph techniques that the students can apply in various fields

UNIT I: Basic Concepts (12 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, Tree ADT

UNIT II: Algorithm Design Mode (12 Hours)

Greedy Method - Divide and Conquer - Dynamic Programming – Backtracking - Branch and Bound

UNIT III: Trees and Hashing (12 Hours)

Trees: Binary Tree, Binary Search Tree, AVL Tree, Tree Traversal, B-Tree. **Hashing**: General Idea, Hash Function, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing, Priority Queues, Model, Simple Implementations, Binary Heap, Applications

UNIT IV: Sorting (12 Hours)

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

UNIT V: Graphs (12 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
Assessment Methods	MCQ, Assignment, Slip test

Books for Study:

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

Books for Reference:

1. Baase, S. and Allen Van Gelder (2008). *Computer Algorithms Introduction to Design and Analysis*. Pearson Education, New Delhi.
2. Goodrich, M.T. and R. Tamassia (2006.). *Algorithm Design: Foundations, Analysis, and Internet Examples*. Wiley, New Delhi.

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**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	Analyse 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	**25PDS1ES01A**		**Discipline Specific Elective 1:** Data Structures & Algorithms							**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	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	Credits
1	25PDS1ES01B	**Discipline Specific Elective - 1:** Internet of Things	4	3

Course Objectives
To recall the basics of Internet of things and protocols
To explain the protocol Standardization for IoT
To identify the role of Internet of Things and its application areas
To distinguish between the Web of Things versus Internet of Things
To perceive and discuss the gist of Industrial Internet of Things

UNIT I: IoT Ecosystem Concepts and Architectures (12 Hours)

Introduction – IoT definition and evolution – IoT Architectures – Open IoT Architecture for IoT/Cloud Convergence - Resource Management – IoT Data Management and Analytics - Communication Protocols – Internet of Things applications - Scheduling Process and IoT Services Lifecycle - IoT enabling technologies – IoT levels and Deployments templates – Introduction to M2M - Difference between IoT and M2M – SDN and NFV for IoT

UNIT II: IoT Data and Framework Essentials (12 Hours)

Introduction - Programming framework for IoT– The foundation of Stream processing in IoT - Continuous Logic processing system – Challenges and Future directions – Anomaly detection – Problem statement and definitions – Efficient incremental local modelling – IoT Governance

UNIT III: RF Protocols RFID, NFC; IEEE 802.15.4 (12 Hours)

ZigBee - ZWAVE, THREAD - Bluetooth Low Energy (BLE) - IPv6 for Low Power and Lossy Networks (6LoWPAN) - Routing Protocol for Low power and lossy networks (RPL) - CoAP - XMPP - Web Socket-AMQP – MQTT – WebRTC - PuSH Architectural Considerations in Smart Object Networking - TinyTO Protocol. 3.2 Introduction to IoT based applications – Scenarios – Architecture overview – Sensors – The gateway – Data Transmission – Internet of Vehicles (IoV) – IoV Characteristics, Technologies and its application

UNIT IV: Developing Internet of Things (12 Hours)

Introduction – IoT Design Methodology – Case study on IoT system for Weather monitoring – IoT Device - IoT physical devices and endpoints - Exemplary Device: Raspberry Pi - Linux on Raspberry Pi - Raspberry Pi interfaces – Programming Raspberry Pi and with python – Other IoT devices

UNIT V: IoT Reliability, Security and Privacy (12 Hours)

Introduction - Concepts - IoT Security Overview – Security Frameworks for IoT – Privacy in IoT networks - IoT characteristics and reliability issues - Addressing reliability

Teaching Methodology	Instructive method, Problem solving, Group Discussion
Assessment Methods	MCQ, Assignment and Seminar

Books for Study:

1. Arshdeep Bahga, Vijay Madisetti. (2015). *Internet of Things, A Hands -on Approach.* (1st Ed.). University Press
2. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. (2016). *Internet of Things: Principles and paradigms*. Elsevier.
3. Her sent, Olivier, David Boswar thick, and Omar Elloumi. (2011). *The Internet of Things: Key applications and protocols*. John Wiley & Sons.

Books for Reference:

1. Bernd Scholz-Reiter, Florian Michahelles. *Architecting the Internet of Things*. Springer
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Aves and, Stamatis Karnous kos, David Boyle. (2014). *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*. (1st Ed.). Academic Press.
3. Peter Waher. *Learning Internet of Things*. PACKT publishing, Birmingham

Websites and eLearning Sources:

1. https://thingsee.com/blog/quality-hardware-list-for-your-iot-projects
2. https://tools.ietf.org/html/rfc7452. http://dret.net/lectures/iot-spring15/protocols
3. http://iot.intersog.com/blog/overview-of-iot-development-standards-andframeworks

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Recall IoT concepts, architectures, enabling technologies, and differences from M2M.	**K1**
CO2	Apply IoT programming frameworks and stream processing for real-time data analysis.	**K2**
CO3	Demonstrate knowledge of RF protocols like RFID, NFC, ZigBee, BLE, and 6LoWPAN.	**K3**
CO4	Design and develop IoT solutions using Raspberry Pi, sensors, gateways, and cloud.	**K4**
CO5	Assess IoT security, privacy concerns, reliability issues, and security frameworks.	**K5**
CO6	Develop and evaluate IoT applications in smart cities, healthcare, and automation.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PDS1ES01B**	**Discipline Specific Elective - 1:** Internet of Things								**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 / Weeks	Credits
1	25PDS1AE01	**Ability Enhancement Course:** Data Analytics using Excel	2	1

Course Objectives
Understand and utilize key Excel features for data science applications.
Perform data cleaning, preprocessing, and transformation using Excel functions.
Apply statistical and analytical tools for data-driven decision-making.
Create interactive and dynamic visualizations using Excel charts and PivotTables.
Automate tasks using Excel formulas, macros, and VBA (basic level).

UNIT I: Introduction to Data Science and Excel (6 Hours)

Overview of Data Science and its applications - Introduction to Excel as a tool for data analytics, Excel interface, functions, shortcuts, Data entry, formatting, and conditional formatting.

UNIT II: Data Handling and Cleaning (6 Hours)

Importing data into Excel (CSV, Text, JSON) - Data cleaning techniques: removing duplicates, handling missing values - Text processing functions: LEFT, RIGHT, MID, LEN, FIND, SUBSTITUTE - Using Flash Fill and Power Query for data transformation.

UNIT III: Data Manipulation with Excel Functions (6 Hours)

Logical functions: IF, AND, OR, IFERROR - Lookup functions: VLOOKUP, HLOOKUP, XLOOKUP, INDEX-MATCH - Date and time functions - Aggregation and summarization techniques

UNIT IV: Data Visualization Techniques (6 Hours)

Charts and graphs (Bar, Line, Pie, Scatter, Histogram) - PivotTables and PivotCharts for data summarization - Conditional formatting for visualization - Interactive dashboards using slicers and timelines

UNIT V: Introduction to Excel Automation (6 Hours)

Creating and using Macros for automation - Basics of VBA for data science applications - Automating repetitive tasks with VBA scripts - Introduction to Power Pivot and Power Query

Teaching Methodology	Lecture-Based Learning, Hands-On Practical Sessions, Peer Learning and Discussions.
Assessment Methods	Continuous Assessment, Practical Exercises, Mini Project and Final Examination

Books for Study:

1. Wayne L. Winston. (2024). *Microsoft Excel Data Analysis and Business Modeling (Office 2021 and Microsoft 365)*, PHI Learning.

Books for Reference:

1. Michael Alexander. (2022). *Excel Power Query & Power Pivot For Dummies*, Wiley.
2. Kenneth N. Berk & Patrick Carey. (2003). *Data Analysis with Microsoft Excel*, Pacific Grove.

Websites and eLearning Sources:

1. https://www.geeksforgeeks.org/data-analysis-in-excel/
2. https://www.datacamp.com/courses/data-analysis-in-excel
3. https://www.coursera.org/projects/introduction-data-analysis-microsoft-excel

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Understand the fundamentals of data science and utilize Excel as a tool for data analytics, including data entry, formatting, and conditional formatting.	**K1**
CO2	Demonstrate proficiency in data handling and cleaning by importing various data formats into Excel, applying text processing functions, and using tools like Flash Fill and Power Query.	**K2**
CO3	Apply data manipulation techniques using logical, lookup, and date-time functions to process and analyze data efficiently.	**K3**
CO4	Develop data visualization skills by creating charts, PivotTables, and interactive dashboards to summarize and present data effectively.	**K4**
CO5	Implement automation techniques in Excel by creating and using Macros, VBA scripts, and Power Query for efficient data handling.	**K5**
CO6	Enhance problem-solving abilities in data analytics through hands-on experience in data cleaning, transformation, visualization, and automation using Excel.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PDS1AE01**	**Ability Enhancement Course:** Data Analytics Using Excel								**2**	**1**
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	2	2	2	3	2	2	2	2	**2.2**
CO2	2	3	3	2	2	2	3	3	2	2	**2.4**
CO3	2	3	3	2	1	2	3	3	2	1	**2.2**
CO4	2	2	2	2	2	3	2	2	2	2	**2.1**
CO5	2	3	3	2	2	2	3	3	2	1	**2.3**
CO6	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 / Weeks	Credits
1	25PDS1OE01	**Open Elective (WS):** SQL and NoSQL for Data Science	4	2

Course Objectives
To introduce fundamental concepts of SQL and relational databases
To develop proficiency in data retrieval and aggregation techniques
To understand advanced SQL concepts
To explore NoSQL databases and their applications
To apply SQL and NoSQL techniques in real-world data science scenarios

UNIT I: Fundamentals of SQL and Relational Databases (12 Hours)

Introduction to Relational Databases-Basics of SQL: Data Types, Schema Design-Creating and Managing Tables - Create, Alter, drop commands - Insert, Update, Delete operations - Constraints and Keys - Primary Key, Foreign Key, Unique, Not Null, Check-SQL Operators (Arithmetic, Logical, Comparison)-String Functions and Numeric Functions

UNIT II: Data Retrieval and Aggregation in SQL (12 Hours)

Select Statement and Where Clause - Order By & Group By Clauses - Having Clause vs. Where Clause-Aggregate Functions: Count, Sum, Avg, Min, Max - Subqueries and Nested Queries - SQL Aliases (Table & Column) - Joins in SQL: Inner Join, Left Join, Right Join, Full Join, Cross Join-Working with Views and Indexing.

UNIT III: Advanced SQL & Database Normalization (12 Hours)

Normalization: 1NF, 2NF, 3NF, BCNF - Denormalization and Performance Optimization-Transactions in SQL: Commit, Rollback, Save point - Concurrency Control: ACID Properties-Window Functions (Rank, Dense Rank, Row Number)-SQL Stored Procedures, Triggers, and Functions.

Use Case: *Customer Analytics, Sales Forecasting, Business Intelligence with SQL*

UNIT IV: Introduction to NoSQL Databases (12 Hours)

Overview & Evolution of NoSQL Databases-Difference Between SQL and NoSQL-Types of NoSQL Databases-Key-Value Stores (Redis, DynamoDB)-Document-Oriented Databases (MongoDB, CouchDB)-Column-Family Stores (Cassandra, HBase)-Graph Databases (Neo4j)-Advantages & Challenges of NoSQL-Sharding, Replication, and Scaling NoSQL Database.

UNIT V: Working with NoSQL for Data Science (12 Hours)

Document-Oriented Databases (MongoDB) - CRUD Operations in MongoDB-Aggregation Framework & Indexing-Schema Design in NoSQL-Column-Family Stores (Apache Cassandra & HBase) -Architecture and Querying Techniques-Graph Databases (Neo4j) Property Graph Model-Graph Analytics (PageRank, Community Detection

Use case Real-time: Analytics*-Recommendation Systems, Social Network Analysis*

Teaching Methodology	Lecture-Based Learning, Hands-On Practical Sessions, Peer Learning and Discussions.
Assessment Methods	Continuous Assessment, Assignment and Final Examination

Books for Study:

1. Sadalage, P. & Fowler. (2022). *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence* (1st Ed.), Wiley Publications.

Books for Reference:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan. (2019). *Database System Concepts* (7th Ed.), MeGraw Hill.
2. Renee M. P. Teate. (2021). *SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis*, Wiley.
3. Shannon Bradshaw, Eoin Brazil. (2020). *MongoDB: The Definitive Guide* (3rd Ed.), Oreilly.

Websites and eLearning Sources:

1. https://www.oracle.com/in/database/nosql/technologies/nosql/
2. https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRNp
3. https://www.geeksforgeeks.org/introduction-to-nosql/
4. https://www.javatpoint.com/nosql-database

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Demonstrate an understanding of relational database concepts and execute fundamental SQL commands for database creation and management.	**K1**
CO2	Retrieve and manipulate data efficiently using SQL queries, including filtering, grouping, aggregation, and joins.	**K2**
CO3	Apply normalization techniques to optimize database design and implement transaction control for data consistency and integrity.	**K3**
CO4	Analyze and implement NoSQL database models, including key-value, document-oriented, column-family, and graph databases.	**K4**
CO5	Perform CRUD operations and indexing in NoSQL databases such as MongoDB, Cassandra, and Neo4j for data-intensive applications.	**K5**
CO6	Utilize SQL and NoSQL databases in data science applications, such as real-time analytics, recommendation systems, and social network analysis.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**25PDS1OE01**	**Open Elective (WS):** SQL and NoSQL for Data Science								**4**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Scores of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**	
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/ Weeks	Credits
1	25PGC1SL01	**Self-Learning Course:** Global Citizenship Education	Online	1

Course Objectives
To develop an understanding of global governance structures, rights and responsibilities.
To recognize and respect differences, multiple identities and diversity.
To examine beliefs and perceptions about social justice, equality and civic engagement.
To develop attitudes of care and empathy for others and the environment.
To develop global competence and ethical considerations by enhancing communication and collaboration skills across cultures

UNIT I: Introduction to Global Citizenship

01. Historical and Philosophical Foundations of Global Citizenship
02 Rights and Responsibilities of Global Citizenship
03. Key Organizations and Movements Promoting Global Citizenship

UNIT II: Globalization and Its Impact on Society

04. Globalization and Its Key Drivers
05. Positive and Negative Impacts of Globalization
06. Role of Education in Fostering a Global Perspective

UNIT III: Human Rights, Social Justice, Equality and Diversity

07. Key Human Rights Treaties, Frameworks and Declarations
08. Advocacy, Activism, and Movements for Social Justice and Equality
09. Global Challenges to Human Rights, Equality and Diversity

UNIT IV: Sustainable Development and Environmental Responsibility

10. The Sustainable Development Goals and Their Relevance to Global Citizenship
11. Climate Change, Environmental Degradation and Sustainable Development
12. Strategies for Promoting Environmental Responsibility

UNIT V: Building Global Competence and Engagement

13. Effective Communication and Collaboration Across Cultures
14. Volunteering and Community Engagement in Global Initiatives
15. Ethical Considerations in Global Citizenship

Teaching Methodology	Recorded Lectures/Videos, Reading Materials, PPTs, Case Studies, Collaborative Projects, Quizzes and Polls
Assessment Methods	Seminars, Assignments, MCQs, Reflection Essays, Group Project Presentations, Problem-Solving Scenarios

Books for Study:

1. Clapham, A. (2007). *Human rights: A very short introduction.* Oxford University Press.
2. Desai, A. (2018). *Global citizenship and cultural diplomacy: India's role in a changing world*. Routledge India.
3. Gould, J. A. (2012). *The ethics of global citizenship*. Routledge.
4. Held, D., et al. (2022). *Globalization and its impact on the developing world*. Cambridge University Press.
5. Sen, A. (2009). *The idea of justice*. Penguin Books India.

Books for Reference:

1. Ghosh, A. (2007). *The global impact of Indian civilization*. HarperCollins India.
2. Krecker, E. (2008). *The global citizen: A guide to creating an international life and career*. Career Press.
3. Kumar, R. (2017). *Sustainable development and environmental justice in India*. Oxford University Press.

4. Nair, K. G. (2014). *Human rights: A socio-political perspective*. Orient Blackswan.
5. Patel, V. (2015). *Social justice and equality in India: Theories and practices*. Oxford University Press.
6. Pillai, V. (2016). *Globalization and its impact on Indian society*. SAGE Publications India.

Websites and eLearning Sources:

1. https://www.unesco.org/en/global-citizenship-peace-education/need-know
2. TEDxCincinnati: Global Citizenship in the Classroom: Jenny Buccos at TEDxCincinnati https://www.youtube.com/watch?v=6jjLHmyBs7o
3. Social justice -- is it still relevant in the 21st century? | Charles L. Robbins | TEDxSBU https://www.youtube.com/watch?v=Wtroop739uU
4. Are We the Last Generation — or the First Sustainable One? | Hannah Ritchie | TED https://www.youtube.com/watch?v=Kl3VVrggKz4
5. Diversity, Equity & Inclusion. Learning how to get it right | Asif Sadiq | TEDxCroydon https://www.youtube.com/watch?v=HR4wz1b54hw

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	Recall the historical, philosophical and practical foundations of global citizenship.	**K1**
CO2	Explain the key drivers of globalization and the role of education in fostering a global perspective.	**K2**
CO3	Apply human rights frameworks, social justice principles, and advocacy strategies to real-world challenges.	**K3**
CO4	Analyze the relevance of the Sustainable Development Goals in addressing climate change and environmental degradation.	**K4**
CO5	Develop strategies for fostering global competence by enhancing communication and collaboration skills across cultures.	**K5**
CO6	Critically evaluate the effectiveness of current global strategies and policies in addressing social justice and environmental sustainability.	**K6**

Semester	Course Code	Title of the Course	Hours/ Weeks	Credits
2	25PDS2CC04	**Core Course - 4:** Statistics - II	5	4

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 – I (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 two variances using F-test - Chi-square distribution and its properties (without proofs) - Chi-square test 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-The Runs 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
Assessment Methods	MCQ, Assignment, Seminar

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.
4. Gupta. S. P (2008). Statistical Method, (37th Ed). Sultan Chand & Sons.

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 Sources:

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**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	**25PDS2CC04**		**Core Course - 4:** Statistics - 2							**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**	**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 / Weeks	Credits
2	25PDS2CC05	**Core Course - 5:** Machine Learning	5	3

Course Objectives
To learn what machine learning is and how to build as imple machine learning model using Python
To choose the right machine learning classifier for a problem and train it using scik it-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: Introduction to Machine Learning (15 Hours)

Introduction: Machine Learning Foundations – Overview – Design of a Learning System – Types of Machine Learning – Supervised Learning and Unsupervised Learning – Applications of Machine Learning – Tools Overview for ML.

UNIT II: Regression Techniques in Supervised Learning (15 Hours)

Supervised Learning – I: Simple Linear Regression – Multiple Linear Regression – Polynomial Regression – Ridge Regression – Lasso Regression – Evaluating Regression Models – Model Selection – Bagging – Ensemble Methods.

UNIT III: Classification Techniques in Supervised Learning (15 Hours)

Supervised Learning – II: Classification – Logistic Regression – Decision Tree Regression and Classification – Random Forest Regression and Classification – Support Vector Machine Regression and Classification - Evaluating Classification Models.

UNIT IV: Unsupervised Learning Techniques (15 Hours)

Unsupervised Learning: Clustering – K-Means Clustering – Density-Based Clustering – Dimensionality Reduction – Collaborative Filtering.

UNIT V: Advanced Learning Techniques (15 Hours)

Association Rule Learning and Reinforcement Learning: Association Rule Learning – Apriori – Eclat – Reinforcement Learning – Upper Confidence Bound – Thompson Sampling – Q-Learning.

Teaching Methodology	Lecture-based Learning, Project-based learning,
Assessment Methods	MCQ, Snap Test

Books for Study:

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.

Books for Reference:

1. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
2. Sebastian Raschka, Vahid Mirjilili,” Python Machine Learning and deep learning”, 2 nd edition, kindle book, 2018
3. Carol Quadros,” Machine Learning with python, scikit-learn and Tensorflow”, Packet Publishing, 2018
4. Gavin Hackeling,” Machine Learning with scikit-learn”, Packet publishing, O’Reily, 2018
5. Stanford Lectures of Prof. Andrew Ng on Machine Learning
6. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.

Websites and eLearning Sources:

1. https://data-flair.training/blogs/machine-learning-tutorial/
2. https://www.packtpub.com/application-development/complete-machine-learning-course-python-video
3. https://www.geeksforgeeks.org/machine-learning/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of his course, students will be able to		
CO1	Understand the concepts of Machine learning.	**K1**
CO2	Understand and distinguish Supervised, Unsupervised and	**K2**
CO3	Reinforcement Learning.	**K3**
CO4	Apply Supervised, Unsupervised and semi supervised	**K4**
CO5	Algorithms for a specific problem	**K5**
CO6	Solve nonlinear classification problems using a kernel SVM	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**25PDS2CC05**			**Core Course - 5:** Machine Learning						**5**	**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	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
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
2	25PDS2CC06	**Core Course – 6:** Big data Analytics	4	3

Course Objectives
To understand the fundamental concepts, types, and applications of machine learning.
To apply regression techniques to develop predictive models in supervised learning.
To analyze classification methods and evaluate their performance in machine learning tasks.
To explore unsupervised learning techniques such as clustering and dimensionality reduction.
To implement association rule learning and reinforcement learning techniques to solve real-world problems.

UNIT I: Introduction to Big Data and Hadoop (12 Hours)

Big Data and its importance – Sources of Big Data – Characteristics of Big Data – Big Data Analytics – Big Data Applications, Hadoop Distributed File System – Map Reduce Paradigm- Hadoop Ecosystem

UNIT II: Spark Programming with Python (12 Hours)

Apache Spark Ecosystem – Resilient Distributed Datasets – Spark Architecture -Loading and Storing Data – Transformations – Actions – Key-Value Resilient Distributed Datasets – Local Variables – Broadcast Variables – Accumulators – Partitioning – Persistence.

UNIT III: Spark SQL (12 Hours)

Overview of Spark SQL – Spark Session – Data Frames – Schema of a Data Frame – Operations supported by Data Frames – Filter, Join, Group By, Agg operations – Nesting the Operations – Temporary Tables – Viewing and Querying Temporary Tables.

UNIT IV: Machine Learning with Spark (12 Hours)

Linear Regression – Decision Tree Classification – Principal Component Analysis – Random Forest Classification – Text Pre-processing with TF-IDF –Naïve Bayes Classification – K-Means Clustering – Recommendation Engines.

UNIT V: Spark Streaming (12 Hours)

Use Cases for Real time Analytics – Transferring, Summarizing, Analysing Real time data – Data Sources supported by Spark Streaming – Flat files, TCP/IP –D D Streams operations.

Teaching Methodology	Videos, PPT, Black board, Demonstration, Exercises
Assessment Methods	MCQ, Snap Test

Books for Study:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O‟reilly Media, 2011
3. Tomasz Drabos, “Learning PySpark”, PACKT, 2017.

Books for Reference:

1. Padma Priya Chitturi, “Apache Spark for Data Science”, PACKT, 2017.
2. Holden Karau, “Learning Spark”. PACKT, 2016.
3. Sandy Riza, “Advanced Analytics with Spark”, O’ Reilly, 2016.
4. Romeo Kienzler, “Mastering Apache Spark”, PACKT, 2017.

Websites and eLearning Sources:

1. https://spark.apache.org/
2. https://databricks.com/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Remember the fundamental concepts of SPARK Programming.	**K1**
CO2	Understand the architecture and working of Resilient Distributed Datasets (RDD).	**K2**
CO3	Apply algorithmic constructs for implementing RDD operations in Spark.	**K3**
CO4	Illustrate Spark SQL functionalities and temporary table operations.	**K4**
CO5	Analyze and assess Spark Streaming operations using different methods.	**K5**
CO6	Construct and implement solutions for real-world problems using Spark.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**							**Hours**		**Credits**
2	**25PDS2CC06**	**Core Course - 6:** Bigdata Analytics							**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 / Weeks	Credits
2	25PDS2CP02	**Core Practical - 2:** Machine Learning – Lab (Internship Embedded Course)	4	3

Course Objectives
To understand regression, classification, clustering, and association rule learning.
To apply machine learning algorithms to real-world problems.
To analyze different supervised and unsupervised learning techniques.
To explore ensemble methods and boosting techniques.
To compare and evaluate the performance of various machine learning models.

List of Exercises

1. Simple and Multiple Linear Regression
2. Polynomial Regression
3. Bagging Technique
4. Adaboost Methods
5. Logistic Regression algorithm
6. Decision Tree Classification
7. Random Forest Classification
8. SVM Classification
9. K Means Clustering
10. Density based Clustering
11. Apriori algorithm for market basket analysis
12. Comparison of Supervised Machine Learning algorithms

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs
Assessment Methods	Snap Test

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Remember basic machine learning concepts.	**K1**
CO2	Understand different regression, classification, and clustering techniques.	**K2**
CO3	Apply machine learning algorithms to datasets.	**K3**
CO4	Analyze and compare model performance.	**K4**
CO5	Evaluate machine learning methods for different tasks.	**K5**
CO6	Create machine learning solutions for real-world problems.	**K6**

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
2	25PDS2CP02	**Core Practical - 2:** Machine Learning – Lab (Internship Embedded Course)	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
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours /Weeks	Credits
2	25PDS2CP03	**Core Practical – 3:** Big data Analytics Lab	4	3

Course Objectives
To understand the concepts of Resilient Distributed Datasets (RDDs) and their operations in Spark.
To apply transformations, actions, and key-value operations on RDDs for efficient data processing.
To explore distributed data handling techniques, including local variables, broadcast variables, and accumulators.
To implement machine learning algorithms like Linear Regression, Decision Trees, and Naïve Bayes using Spark.
To analyze real-time data processing using Flume, Kafka, Kinesis, and Spark Streaming

List of Exercises

1. Program involving Resilient Distributed Datasets
2. Program involving Transformations and Actions
3. Program involving Key-Value Resilient Distributed Datasets
4. Program involving Local Variables, Broadcast Variables, and Accumulators
5. Program involving Filter, Join, GroupBy, Agg operations
6. Viewing and Querying Temporary Tables
7. Transferring, Summarizing, and Analyzing Twitter data
8. Program involving Flume, Kafka, and Kinesis
9. Program involving DStreams and DStream RDDs
10. Linear Regression
11. Decision Tree Classification
12. Principal Component Analysis
13. Random Forest Classification
14. Text Pre-processing with TF-IDF
15. Naïve Bayes Classification
16. K-Means Clustering

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs
Assessment Methods	Snap Test

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Remember the basics of Spark, RDDs, and data processing.	**K1**
CO2	Understand transformations, actions, and distributed computing in Spark.	**K2**
CO3	Apply machine learning models for classification, clustering, and regression.	**K3**
CO4	Analyze real-time data processing and querying in Spark.	**K4**
CO5	Evaluate different machine learning models in big data environments.	**K5**
CO6	Create data-driven solutions using Spark for large-scale analytics.	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
2	**25PDS2CP03**		**Core Practical – 3:** Big data Analytics Lab						**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes**					**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	Credits
2	25PDS2OE02	**Open Elective – 2 (BS):** Discrete Mathematics	4	2

Course Objectives
To introduce Mathematical Logic to understand the equivalence of statements
To acquaint the students with Inference Theory and predicate calculus to understand partial order and partition
To introduce fundamental principles of Combinatorial Counting techniques
To explain generating functions and their utility in solving recurrence relations
To introduce graph models and tree structures with basics and significance of travers ability

UNIT I: Propositional Logic (12 Hours)

Propositions- Conditional Propositions and Logical Equivalence- Arguments and Rules of Inference– Quantifiers- Nested Quantifiers – Propositional Calculus-Getting Started with Proofs-Methods of Proof-Logic in Proofs-Analysis of Arguments.

UNIT II: Functions and Relations (12 Hours)

Sets-Some Special Sets-Set Operations–Functions–Sequences-Properties of Functions-Relations- Digraphs and Graphs–Matrices-Equivalence Relations and Partitions- The Division Algorithm and Integers Modp.

Induction and Recursion: Loop Invariants-Mathematical Induction- Recursive Definitions- Recurrence Relations- More Induction- The Euclidean Algorithm.

Algorithms: Introduction-Examples of Algorithms-Recursive Algorithms.

UNIT III: Counting Techniques (12 Hours)

Basic Counting Techniques-Elementary Probability –Inclusion-Exclusion and Binomial Methods- Counting and Partitions-Permutations and Combinations, Binomial Coefficients and Identities, Generalized Permutations and Combinations, Generating Functions, Pigeon -Hole Principle.

UNIT IV: Graphs and Trees (12 Hours)

Graphs-PathsandCycles-EdgeTraversalProblems-HamiltonianCyclesandtheTravelingSalesperson Problem-A Shortest-Path Algorithm- Representations of Graphs-Isomorphisms of Graphs- Planar Graphs. Trees-Terminology and Characterizations of Trees- Spanning Trees-Minimal Spanning Trees.

UNIT V: Recursion and Digraphs (12 Hours)

Rooted Trees-Binary Trees-Tree Traversals-Decision Trees- General Recursion-Depth- First Search Algorithms- Polish Notation- Weighted Trees–Digraphs- Digraphs Revisited -Weighted Digraphs.

Teaching Methodology	Lecture-based Instruction, Technology-based Learning, Group Learning, Individual Learning, Inquiry-based Learning.
Assessment Methods	MCQ, Assignment, Seminar

Books for Study:

1. Kenneth A. Rossand Charles R. B. Wright. (2002).*Discrete Mathematics* (5^{th} ed.).Pearson Education.
2. Richard Johnson baugh. (2018).*Discrete Mathematics*(8^{th} ed.).Pearson Education.

Books for Reference:

1. Kenneth H. Rosen. (2006). *Discrete Mathematics and its Applications*(8^{th}ed.).Tata McGraw Hill.
2. Susanna S. Epp. (2011).*Discrete Mathematics with Applications*(4^{th}ed.).Brooks/Cole.
3. Kevin Ferland. (2009). *Discrete Mathematics an Introduction to Proofs and Combinatorics* (1st ed.). Houghton Mifflin Company.

Websites and eLearning Sources:

1. https://www.tutorialspoint.com/discrete_mathematics/discrete_mathematics_introduction.htm
2. https://www.cs.odu.edu/~toida/nerzic/content/intro2discrete/intro2discrete.html

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Recall the fundamental concepts of discrete mathematics, including sets, functions, relations, graphs, and trees.	**K1**
CO2	Interpret and analyse the relationships between different mathematical concepts.	**K2**
CO3	Apply mathematical reasoning techniques, including induction and recursion, to prove mathematical statements.	**K3**
CO4	Analyse and Decompose complex problems into smaller, more manageable subproblems.	**K4**
CO5	Evaluate the efficiency and correctness of discrete mathematical algorithms and techniques	**K5**
CO6	Develop mathematical models of real-world problems	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**25PDS2OE02**	**Open Elective - 2 (BS):** Discrete Mathematics								**4**	**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	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/ Weeks	Credits
2	25PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	2

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, PPT, Mathematical models, Video presentation

Books 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 Reference:

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 & Interviews? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). Hiring the Best: A Manager 's Guide to Effective Interviewing and Recruiting

Websites and eLearning Sources:

1. https://www.indeed.com/career-advice/resumes-cover-letters/communication-skills
2. https://www.seek.com.au/career-advice/article/50-communication-skills-for-the-workplace-your-resume
3. https://southeast.iu.edu/career/files/power-phrases.pdf
4. https://dese.ade.arkansas.gov/Files/20201209124449_Professional-Communication.docx

5. https://www.dol.gov/sites/dolgov/files/ETA/publications/00-wes.pdf
6. https://www.tmu.ac.in/other_websites/cdoe.tmu.ac.in.old/study-material/28-08-2024/COMMON/SEMESTER_2/MAIN_SOFT_SKILLS.pdf
7. https://byjus.com/maths/profit-and-loss-questions/
8. https://www.indiabix.com/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
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	**25PSS2SE01**		**Skill Enhancement Course:** Soft Skills							**4**	**2**
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	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 / Weeks	Credits
2	**25PDS2PW01**	Mini Project – 1	**0**	**1**

Course Objectives
To Develop Programming Skills
To Apply Data Analysis Techniques
To Implement Machine Learning Algorithms
To Enhance Problem-Solving Skills
To Improve Communication and Presentation Skills

- The mini-project is designed to assess students' skills in programming, machine learning, and data analysis. It should be completed individually during the second semester.
- Students must submit a project synopsis by the end of the second semester.
- The synopsis should define the problem, explain its scope, and outline the plan to solve it. The project must be original, and plagiarism will result in cancellation.
- In the third semester, students will present their work, including data collection, analysis, model training, and accuracy.
- The project will be evaluated by a faculty committee based on originality, technical understanding, and presentation quality.
- Students should choose an interesting problem and plan the project in stages: data collection, pre-processing, model training, and evaluation.
- Relevant tools should be used throughout the project. Good documentation and a clear presentation are essential for explaining the work and results.
- This project provides an opportunity to apply what you've learned and solve a real-world problem.

Teaching Methodology	Hands-on Labs, Project-based Learning
Assessment Methods	Project Work Dissertation

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Understand the basics of programming, data analysis, and machine learning.	**K1**
CO2	Apply basic programming skills to solve problems.	**K2**
CO3	Analyze data to identify insights and patterns.	**K3**
CO4	Develop and implement machine learning models.	**K4**
CO5	Evaluate the performance of machine learning models.	**K5**
CO6	Present the results clearly through reports and presentations.	**K6**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3	25PDS3CC07	**Core Course - 7:** Deep Learning	5	3

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 back propagation 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
Assessment Methods	Snap Test, MCQ, Assignment

Books for Study:

1. S. N. Sivanandam, S. N. Deepa. (2018). Principles of Soft Computing. (3rd ed.). Wiley Publication.
2. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka. (2019). Deep Learning using Python. (1st ed.). Wiley Publication.

Books for Reference:

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

Websites and eLearning Sources:

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**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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 modelling tasks	**K4**
CO5	Evaluate the effectiveness of Auto encoders and RBMs in feature extraction	**K5**
CO6	Create flowcharts for the training processes of all the networks	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
3	**25PDS3CC07**			**Core Course - 7:** Deep Learning					**5**		**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	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
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3	25PDS3CC08	**Core Course - 8:** Artificial and Computational Intelligence	5	3

Course Objectives
To introduce fundamental concepts of Artificial Intelligence (AI)
To explore Natural Language Processing techniques
To understand Generative AI techniques
To study Edge AI technologies
To analyze the conversational tools

UNIT I: AI Fundamentals (15 Hours)

Fundamental Issues in Intelligent Systems: AI Definitions - Attitude towards intelligence – knowledge - human artifice - Example of an AI Technique.

Problem Solving using Search Strategies: (15 Hours)

Problem Spaces - Strategies for State Space Search - Heuristic Search: Generate & Test - Hill Climbing - Best First - Problem Reduction - Constraint Satisfaction - Properties of Heuristics like Admissibility – Monotonicity - Informed ness. Adversarial Search (Game Playing): Minimax - Alpha-Beta Cutoffs - Planning: An Example - Goal Stack - Hierarchical Planning.

UNIT II: Natural Language Processing and Generative AI (15 Hours)

Natural Language Understanding and Generation - N-gram and Neural Language Models - Introduction to LLM - Introduction to prompt engineering - Word to Vectors / Word Embedding (Skip gram/CBOW, BERT) - Part of Speech Tagging – Parsing - Word Sense Disambiguation - Semantic Web and Knowledge Graph - Introduction to Retrieval Augmented Generation (RAG) – Transformers - Context-based text-processing using Embedding Algorithms.

UNIT III: Computer Vision (15 Hours)

Image formation – Structure – Transformations - Low-level (filters, features, texture) - Mid-level(segmentation, tracking, morphology) - High-Level Vision (registration contour Geometry, Object detection and classification, segmentation) - Deep learning for object Detection – Recognition - Face detection and face recognition - Facial key point recognition - Optical Character Recognition - Visual annotation - Activity recognition - Applications for autonomous cars – Landmark detection and tracking - track pedestrians - 3D projection - Image search and retrieval - Edge devices for computer vision.

UNIT IV: Edge AI (15 Hours)

Edge AI Hardware and Platforms - Edge AI Models and Algorithms - Realtime Processing and Inference - Security and Privacy in Edge AI - Applications of Edge AI.

UNIT V: Generative AI Tools (15 Hours)

Open AI GPT-4- Google Dialog flow - Microsoft Bot Framework – Rasa - IBM Watson Assistant - Hugging Face Transformers - Amazon Lex - Wit.ai – Chatter Bot – Pandora bots

Teaching Methodology	Lecture-Based Learning, Hands-On Programming Sessions, Problem-Solving, Case Studies, Interactive Discussions.
Assessment Methods	Continuous Assessment, Assignment, Final Examination.

Books for Study:

1. Stuart J. Russell and Peter Norvig. (2022) *Artificial Intelligence: A Modern Approach* (4th Ed.), Pearson.
2. Tanvier Siddiqui, U.S. Tiwary. (2021). Natural Language Processing and Information Retrieval, Oxford Higher Education.
3. Mohamed Elgendy. (2020). *Deep Learning for Vision Systems*, Manning Publications.
4. Omar Sanseviero and Pedro Cuenc. (2024) *Hands-on Generative AI,* O'Reilly.

Books for Reference:

1. Kevin Night. (2008). *Artificial Intelligence (SIE)*. McGraw Hill
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**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Demonstrate an understanding of AI fundamentals, including its history, principles, and ethical considerations.	**K1**
CO2	Apply NLP techniques to process and generate human-like text.	**K2**
CO3	Implement ai solutions using Edge AI models and platforms, ensuring real-time processing and security.	**K3**
CO4	Utilize AI methodologies across different domains, such as game theory, automated planning, and AI-driven decision-making.	**K4**
CO5	Develop chatbots with conversational AI	**K5**
CO6	Analyze and apply conversational AI tool	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**25PDS3CC08**	**Core Course - 8:** Artificial and Computational Intelligence								**5**	**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	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
Mean Overall Score											**2.4 (High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3	25PDS3CC09	**Core Course - 9:** Cloud Computing (SSC/Q8302)	4	3

Course Objectives
To introduce fundamental concepts of cloud computing
To explore cloud data management and security
To analyze cloud computing applications in big data and analytics
To understand AI and machine learning services on the cloud
To implement DevOps, serverless computing, and cloud-native applications

UNIT I: Introduction to Cloud Computing (12 Hours)

Overview of Cloud Computing-Essential Characteristics of Cloud Computing-Cloud Computing Architecture & NIST Cloud Reference Model-Cloud Service Models: IaaS, PaaS, SaaS-Cloud Deployment Models: Public, Private, Hybrid, Community-Example Cloud Vendors: AWS, Google Cloud, Azure, OpenStack-Virtualization & Containerization (Docker, Kubernetes)

UNIT II: Cloud Data Management & Security (12 Hours)

Cloud Storage Services: AWS S3, Google Cloud Storage, Azure Blob Storage-Distributed File Systems: HDFS, Cloud Filestore-Data Warehousing on Cloud: BigQuery, Redshift, Snowflake-Cloud Data Governance & Compliance-Cloud Security Considerations: CIA Triad, STRIDE Threat Model-Cloud specific Cryptographic Techniques & Security by Design

UNIT III: Cloud Computing for Big Data & Analytics (12 Hours)

Introduction to Big Data and Cloud Computing-Hadoop as a Service (AWS EMR, Google Dataproc)-MapReduce on Cloud-Apache Spark on Cloud (AWS Glue, Databricks)-Cloud-based ETL Pipelines for Data Science-Real-time Data Streaming (Apache Kafka, AWS Kinesis)-Data Analytics as a Service (DaaS)

UNIT IV: AI & Machine Learning on Cloud (12 Hours)

AI & ML Services on Cloud: AWS SageMaker, Google Vertex AI, Azure ML-Model Training and Deployment on Cloud-AutoML and AI-Powered Analytics-Cloud-Based NLP and Computer Vision Services-Serverless Computing for AI: AWS Lambda, Google Cloud Functions

UNIT V: DevOps, Serverless & Cloud Applications (12 Hours)

Cloud Native Design & Microservices Architecture-12-Factor Application Design-Service Discovery & Service Registry-Function as a Service (FaaS) & Backend as a Service (BaaS)-Serverless Architectures: AWS Lambda, AWS Fargate-DevOps & CI/CD Pipelines (Jenkins, GitHub Actions, AWS CodePipeline)-Cloud Applications: Amazon Simple Notification Service (SNS)-Multi-player Online Game Hosting on Cloud-Building Content Delivery Networks using Cloud

Teaching Methodology	Lecture-Based Learning, Hands-On Sessions, Industry Applications.
Assessment Methods	Continuous Assessment, Assignment, Assessment Test and Final Examination.

Books for Study:

1. Thomas Erl, Ricardo Puttini, and Zaigham Mahmood. (2013). *Cloud Computing: Concepts, Technology & Architecture*, Prentice Hall.
2. Rajkumar Buyya, James Broberg, and Andrzej Goscinski. (2010). *Cloud Computing: Principles and Paradigms*, Wiley.
3. Dan C. Marinescu. (2022) *Cloud Computing: Theory and Practice* (3rd Ed.), Morgan Kaufmann.

Books for Reference:

1. KrisJamsa. (2014). Cloud computing SaaS, PaaS, Virtualization, Business, Mobile securityand more (1st Ed), Jones & Batrlett Students Education.
2. Rajkumar Buyya, Christian Vecchiola, S.Thamaraiselvi. (2013). Mastering cloud computing (1st Ed), Tata McGrawHill.

3. Arshdeep Bahhga and Vijay Madisetti. (2017). Cloud Computing Hands on Approach (1st Ed.), University Press.

Websites and eLearning Sources:

1. https://www.javatpoint.com/cloud-computing-tutorial
2. https://www.simplilearn.com/tutorials/cloud-computing-tutorial
3. https://nptel.ac.in/courses/106/104/106104182/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Demonstrate a strong understanding of cloud computing models, including IaaS, PaaS, SaaS, and various cloud deployment strategies.	**K1**
CO2	Utilize cloud storage and security mechanisms to manage and protect data using platforms like AWS, Google Cloud, and Azure.	**K2**
CO3	Implement big data processing and analytics on the cloud, leveraging technologies such as Hadoop, Apache Spark, and data warehousing services.	**K3**
CO4	Develop AI and machine learning applications on the cloud, using cloud-based tools for model training, deployment, and automation.	**K4**
CO5	Design and deploy cloud-native applications, including serverless computing, DevOps pipelines, and microservices architectures.	**K5**
CO6	Apply cloud-based solutions to real-world applications, such as multiplayer game hosting, content delivery networks, and scalable applications.	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
3	**25PDS3CC09**			**Core Course - 9:** Cloud Computing (SSC/Q8302)						**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	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
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3	25PDS3CP04	**Core Practical – 4:** Deep Learning – Lab	4	2

Course Objectives
To learn the basics of machine learning and deep learning.
To understand how neural networks work and their uses.
To practice implementing machine learning models.
To explore deep learning models like CNNs, RNNs, and LSTMs.
To gain skills in training, testing, and improving machine learning models.

List of Exercises

1. Implement a basic neural network to classify binary data.
2. Create a neural network to solve a non-linear classification problem and demonstrate the effect of back propagation during training.
3. Implement a perceptron for binary classification tasks.
4. Build a neural network using backpropagation and apply it to a classification task with a real dataset.
5. Implement a convolutional neural network (CNN) for image classification tasks.
6. Visualize and interpret the feature extraction process in the convolutional layers of a CNN.
7. Implement a recurrent neural network (RNN) for time-series prediction.
8. Build a long short-term memory (LSTM) network for sequence classification tasks.
9. Implement an autoencoder for data compression or denoising tasks.
10. Build a restricted Boltzmann machine (RBM) for dimensionality reduction and feature learning.

Teaching Methodology	Lectures and Presentations, Hands-on Programming Exercises and Labs
Assessment Methods	Practical

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Understand basic machine learning and deep learning concepts.	**K1**
CO2	Apply neural networks to solve different types of problems.	**K2**
CO3	Build and use machine learning models for various tasks.	**K3**
CO4	Work with deep learning models like CNNs and RNNs.	**K4**
CO5	Use autoencoders and RBMs for data processing and feature extraction.	**K5**
CO6	Evaluate machine learning models and improve their performance.	**K6**

Semester	Course Code	Title of the Course	Hours /Weeks	Credits
3	25PDS3CP05	**Core Practical - 5:** Artificial Intelligence – Lab	4	2

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.
11. Program to Implement Text Generation Using Transformers using Python.
12. Program to Implement Real-Time Inference Using Edge AI.

Teaching Methodology	Hands-on Programming Exercises and Labs, Project Work
Assessment Methods	Lab Exercises, Internal Assessment and Final Practical Examination

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	**25PDS3CP05**			**Core Practical - 5:** Artificial Intelligence – Lab						**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 /Weeks	Credits
3	25PDS3ES02A	**Discipline Specific Elective - 2:** Social Media Analysis	4 (2+2)	3

Course Objectives
To understand how to collect and analyse social media data using APIs and social graphs.
To analyse brand activity and emotions through keyword and sentiment analysis on Facebook.
To perform sentiment and entity analysis on Twitter data.
To analyse campaigns and trends on YouTube using data from GitHub.
To learn web scraping techniques and analyse data from social media platforms like Pinterest.

UNIT I: Social Media Trends and Data Usage (12 Hours)

Introducing social graph - Delving into social data - Understanding the process - Working environment - Getting the data - Analyzing the data - APIs in a nutshell- Introduction to authentication techniques - Parsing API outputs

UNIT II: Exploring Brand Activity and Emotions on Facebook (12 Hours)

Facebook brand page - Project planning- Project planning – Analysis – Keywords - Noun phrases - Detecting trends in time series - Uncovering emotions

UNIT III: Sentiment and Entity Analysis on Twitter (12 Hours)

Scope and process - Getting the data- Sentiment analysis- Customized sentiment analysis - Named entity recognition - Combining NER and sentiment analysis

UNIT IV: Analyzing YouTube Campaigns and Trends on GitHub (12 Hours)

YouTube and Trends Mining on GitHub: Scope and process - Getting the data - Data pull - Data processing - Data analysis.

UNIT V: (12 Hours)

Scraping and Extracting: Scope and process - Getting the data - Data pull and pre-processing - Data analysis. Demystifying Pinterest: Scope and process - Getting the data - Data pull and pre-processing - Data analysis.

Teaching Methodology	Lecturing, Demonstration
Assessment Methods	MCQ, Project

Books for Study:

1. Chatterjee, Siddhartha., Krystyanczuk, Michal, (2017), *Python Social Media Analytics*, Packt Publishing.

Books for Reference:

1. Rashid, Atif, and Umar Farooq (2021), Social Media Analytics and Machine Learning: Applications in Business, CRC Press.
2. Ghosh, Arpan, and Leena Sharma (2019), *Social Media Analytics for Enterprises: A Practical Guide*, Springer.
3. Choudhury, Prithwijit, and Rajarshi Ghosh (2023), *Practical Social Media Analytics: Applications in Business, Healthcare, and Education*, Springer.

Websites and eLearning Sources:

1. https://www.coursera.org/learn/social-media-data-analytics
2. https://www.udacity.com/course/intro-to-data-science--ud359
3. https://www.edx.org/course/data-science-for-social-media

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Identify methods for collecting and analyzing social media data.	**K1**
CO2	Explain how to analyze brand activity and emotions using sentiment analysis.	**K2**
CO3	Apply sentiment analysis and entity recognition on Twitter data.	**K3**
CO4	Analyze YouTube campaign performance and trends.	**K4**
CO5	Evaluate web scraping techniques to extract social media data.	**K5**
CO6	Create processes for extracting, cleaning, and analyzing data from platforms	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**25PDS3ES02A**	**Discipline Specific Elective - 2:** Social Media Analysis								**4 (2+2)**	**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 /Weeks	Credits
3	25PDS3ES02B	**Discipline Specific Elective - 2:** Information Retrieval	4 (2+2)	3

Course Objectives
To teach how documents are processed, indexed, and searched.
To show how to search efficiently and handle special queries.
To explain how statistical models and compression improve retrieval.
To teach how to rank and retrieve documents using vector models.
To help evaluate and improve the usefulness of retrieval systems.

UNIT I: Introduction to Information Retrieval (12 Hours)

An example information retrieval problem- A first take at building an inverted index- Processing Boolean queries- The extended Boolean model versus ranked retrieval.

Document delineation and character sequence decoding- Obtaining the character sequence in a document- Choosing a document unit- Determining the vocabulary of terms -Tokenization- Dropping common terms: stop words,

UNIT II: Search Structures, Wildcard Queries, and Spelling Correction (12 Hours)

Search structures for dictionaries- Wildcard queries- General wildcard queries- k-gram indexes for wildcard queries- Spelling correction- Implementing spelling correction- Forms of spelling correction - Edit distance - k-gram indexes for spelling correction- Context sensitive spelling correction - Phonetic correction.

Hardware basics - Blocked sort-based indexing - Single-pass in-memory indexing - Distributed indexing - Dynamic indexing - Other types of indexes

UNIT III: Statistical Models, Term Properties, and Indexing Techniques (12 Hours)

Statistical properties of terms in information retrieval- Heaps' law: Estimating the number of terms - Zipf's law: Modeling the distribution of terms - Dictionary compression - Dictionary as a string - Blocked storage - Postings file compression- Variable byte codes - ã codes.

Parametric and zone indexes- Weighted zone scoring- Learning weights- The optimal weight g- Term frequency and weighting - Inverse document frequency- Tf-idf weighting

UNIT IV: Vector Space Model and Scoring Techniques (12 Hours)

The vector space model for scoring- Dot products - Queries as vectors - Computing vector scores- Variant tf-idf functions - Sublinear tf scaling- Maximum tf normalization- Document and query weighting schemes - Pivoted normalized document length

UNIT V: Information Retrieval System Evaluation and User Utility (12 Hours)

Information retrieval system evaluation- Standard test collections - Evaluation of unranked retrieval sets - Evaluation of ranked retrieval results- Assessing relevance - Critiques and justifications of the concept of Relevance- A broader perspective: System quality and user utility -System issues - User utility - Refining a deployed system- Results snippets

Teaching Methodology	Lecturing, Demonstration
Assessment Methods	MCQ, Assignment, Snap test

Books for Study:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *"An Introduction to Information Retrieval"*, 1st Edition, Cambridge University Press, 2008

Books for Reference:

1. G.G. Chowdhury, *"Introduction to Modern Information Retrieval"*, 3rd Edition, neal-schuman publishers, 2010.
2. Gerald J. Kowalski, Mark T. Maybury, *"Information storage and Retrieval systems: theory and implementation"*, 2nd Edition, kluwer academic publishers, 2009.

Websites and eLearning Sources:

1. http://nlp.stanford.edu/IR-book/pdf/irbookonlinereading.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Build an inverted index and process Boolean queries.	**K1**
CO2	Design search structures for wildcard queries and spelling correction.	**K2**
CO3	Apply statistical models to improve search results.	**K3**
CO4	Use vector space models and TF-IDF to rank documents.	**K4**
CO5	Evaluate the effectiveness of information retrieval systems.	**K5**
CO6	Develop methods for handling large document collections efficiently.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**25PDS3ES02B**	**Discipline Specific Elective - 2:** Information Retrieval								**4 (2+2)**	**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	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 / Weeks	Credits
3	**25PDS3RM01**	Research Methodology	**4**	**2**

Course Objectives
To understand the fundamental concepts of research methods and methodology
To formulate and define research problems effectively, conduct literature reviews using various sources, and identify research gaps.
To develop proficiency in statistical tools and software
To utilize Power BI for data visualization and analysis, including data preparation, creating basic and advanced visualizations, designing dashboards, and applying DAX functions.
To cultivate proficiency in presenting research findings through effective writing and visual representation

UNIT I: Research Fundamentals **(12 Hours)**

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research.

UNIT II: Problem Formulating **(12 Hours)**

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database. Report Writing

UNIT III: R Programming **(12 Hours)**

Introduction- Fundamentals of R- Variables- Control Flow- Functions- Data Structures- Data Interfaces- Packages in R.

Program: Descriptive Statistics- Perform a one-sample t-test- Perform a two-sample t-test to compare means of two independent samples- Perform a chi-square test on a contingency table to test for independence- Perform a one-way ANOVA on a given dataset- Perform simple linear regression analysis.

UNIT IV: Data Visualization using Power BI **(12 Hours)**

Data Preparation in Power BI- Basic Visualizations- Advanced Visualizations Dashboard Design Principles- Data Analysis and Insights- Storytelling with Data-DAX Functions

Case Studies

1. Hands-on exercises and projects using real-world datasets
2. Case studies of successful Power BI visualizations in industry

UNIT V: Project Report Writing using LaTeX **(12 Hours)**

LaTeX – Fonts – symbols – indenting – paragraphs-line spacing-word spacing-titles and subtitles- Mathematical environments-math mode-Mathematical symbols – graphic-drawing matrices-tables- picture environments-preparing research article – book-project report in LaTeX

Teaching Methodology	Lectures and Discussions, Case Studies and Real -life Examples, Group Projects and Collaborative Learning
Assessment Methods	Assignment, Research Paper Writing, Seminar

Books for Study:

1. Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications.
2. Becker, H. S. (2007). *Writing for social scientists: How to start and finish your thesis, book, or article*. University of Chicago Press.
3. Tilman M. Davies, (2016). The Book of R: A First course in Programming and Statistics, William Pollock.
4. Powell, B. (2017). *Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence*. Packt Publishing.
5. Kopka, H., & Daly, P. W. (2003). *Guide to LaTeX* (4th ed.). Addison-Wesley.

Books for Reference:

1. Kothari C. R. (2004). Research Methodology Methods and Techniques. (2nd ed.). New Age International Publishers, New Delhi.
2. Ranjit Kumar. (2011). Research Methodology -a step-by-step guide for beginners. (3rd ed.). SAGE Publications India Pvt Ltd, India.
3. Panneerselvam R. (2014). Research Methodology. (2nd ed.). New Delhi: Prentice Hall, India.

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	**25PDS3RM01**			Research Methodology						**4**	**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	3	2	2	3	3	3	3	3	3	3	**2.8**
CO2	2	3	3	3	3	2	3	2	3	2	**2.6**
CO3	2	1	2	3	2	3	3	3	1	3	**2.3**
CO4	1	1	2	2	2	1	3	3	1	3	**1.9**
CO5	2	2	2	1	2	1	3	3	3	3	**2.2**
CO6	2	3	2	3	1	3	3	1	3	3	**2.4**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours /Weeks	Credits
3	25PDS3SL03	**Self – Learning:** Mean Stack	-	1

Course Objectives
To introduce fundamental concepts of web technologies and develop interactive web applications using AngularJS.
To implement and manage front-end and back-end development by utilizing AngularJS directives, controllers, and services.
To develop server-side applications using Node.js and Express framework for efficient request handling.
To understand and apply MongoDB for non-relational database management, CRUD operations, and data modeling.
To integrate web technologies, databases, and server-side frameworks for building full-stack applications.

UNIT I: Introduction to Web Technology and Angular JS

Introduction to Web Technology – Angular JS Model-View-Controller – Expression -Directives and Controllers - Angular JS Modules – Arrays –Working with ng-model – Working with Forms –Form Validation – Error Handling with Forms –Nested Forms with ng-form – Other Form Controls.

1. Develop a Form and validate using AngularJS
2. Create and implement modules and controllers in Angular JS
3. Implement Error Handling in Angular JS

UNIT II: Directives and Building Databases

Filters – Using Filters in Controllers and Services –Angular JS Services – Internal Angular JS Services– Custom Angular JS Services - Directives –Alternatives to Custom Directives – Understanding the Basic options – Interacting with Server –HTTP Services – Building Database, Front End and Back End.

1. Create and implement Custom directives
2. Front End and Back End applications.

UNIT III: Node J Sand Express Framework

Introduction –Using the Terminals – Editors –Building a Webserver with Node – The HTTP Module – Views and Layouts – Form Handling with Express - The Request and Response Objects–Handle bars – Comments and Blocks.

1. Create web applications using Express, Node JS and Angular JS
2.Form Handling with Express
3.Handle bars, Comments and Blocks

UNIT IV: Introduction To MongoDB

JSON and MongoDB – Adopting a Non-relational Approach – Opting for Performance vs. Features Running the Database Anywhere – Generating or Creating a Key – Using Keys and Values –Implementing Collections

1. Implement CRUD operations in MONGODB

UNIT V: Data Models

Designing the Database – Building Indexes –Inserting Data – Querying for Data – Updating Data – Removing Data – Referencing a Database.

1. Implement MongoDB data models

Teaching Methodology	Lecture-Based Learning, Hands-On Practical Sessions, Project-Based Learning, Interactive Discussions and Code Reviews.
Assessment Methods	Continuous Assessment, Mini Project and Final Examination

Books for Study:

1. Simon Holmes, Clive Herber. (2022). *Getting MEAN with Mongo, Express, Angular, and Node*, Manning Publications
2. Agus Kurniawan. (2014). *AngularJS Programming by Example* (1st Ed.), PE Press.
3. David Hows, Peter Membrey, Eelco Plugge. (2014). *MongoDB Basics,* A press.
4. Ethan Brown. (2014). *Web Development with Node and Express* (1st Ed.), Oreilly Publisher.

Books for Reference:

1. By Colin J Ihrig, Adam Bretz. (2015). Full Stack JavaScript Development with MEAN MongoDB, Express, AngularJS, and Node.JS, Site Point Pty Limited.

Websites and eLearning Sources:

1. https://www.geeksforgeeks.org/introduction-to-mean-stack/https://www.icmr.nic.in/
2. https://www.javatpoint.com/mean-stack-tutorial
3. https://www.sitepoint.com/introduction-mean-stack/

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Demonstrate proficiency in AngularJS by creating dynamic web applications with forms, validation, and error handling.	**K1**
CO2	Implement AngularJS directives, filters, and services to enhance application functionality and manage data efficiently.	**K2**
CO3	Develop web applications using Node.js and Express framework, handling HTTP requests, responses, and form submissions.	**K3**
CO4	Apply CRUD operations in MongoDB for database management, including inserting, updating, and deleting data.	**K4**
CO5	Design and implement MongoDB data models with indexing and querying techniques for optimized performance.	**K5**
CO6	Integrate AngularJS, Node.js, Express, and MongoDB to develop and deploy full-stack web applications.	**K6**

Relationship Matrix												
Semester	**Course Code**	**Title of the Course**									**Hours**	**Credits**
3	**25PDS3SL03**	**Self – Learning - 3:** Mean Stack									**-**	**1**
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 / Weeks	Credits
3	**25PDS3PW02**	Mini Project – 2	**0**	**1**

Course Objectives
To Develop Programming Skills
To Apply Data Analysis Techniques
To Implement Machine Learning Algorithms
To Enhance Problem-Solving Skills
To Improve Communication and Presentation Skills

- The mini-project is designed to assess students' skills in programming, machine learning, and data analysis. It should be completed individually during the third semester.
- Students must submit a project synopsis by the end of the second semester. The synopsis should define the problem, explain its scope, and outline the plan to solve it.
- The project must be original, and plagiarism will result in cancellation. In the third semester, students will present their work, including data collection, analysis, model training, and accuracy.
- The project will be evaluated by a faculty committee based on originality, technical understanding, and presentation quality.
- Students should choose an interesting problem and plan the project in stages: data collection, pre-processing, model training, and evaluation.
- Relevant tools should be used throughout the project. Good documentation and a clear presentation are essential for explaining the work and results.
- This project provides an opportunity to apply what you've learned and solve a real-world problem.

Teaching Methodology	Hands-on Labs, Project-based Learning
Assessment Methods	Project Work

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Understand the basics of programming, data analysis, and machine learning.	**K1**
CO2	Apply basic programming skills to solve problems.	**K2**
CO3	Analyze data to identify insights and patterns.	**K3**
CO4	Develop and implement machine learning models.	**K4**
CO5	Evaluate the performance of machine learning models.	**K5**
CO6	Present the results clearly through reports and presentations.	**K6**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
3		Internship	**0**	**2**

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

Internship		
Sl. No.	**Area of Work**	**Maximum**
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, Testing etc., and Presentation	**25**
3	Documentation	**25**
4	Viva Voce Examination	**25**
	TOTAL	**100**

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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, and interpersonal communication.	**K3**
CO4	Develop problem-solving and critical thinking skills to address real-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**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
4	25PDS4CC10	**Core Course - 10:** Data Science for Enterprises	5	4

Course Objectives
To understand different data collection and preprocessing methods.
To learn how to use predictive analytics techniques like regression and classification in business.
To explore machine learning applications for solving real-world business problems.
To gain skills in advanced data analysis and visualization tools for business insights.
To work on capstone projects that apply data science skills to solve business problems.

UNIT I: Data Collection, Integration, and Preprocessing (15 Hours)

Data Collection Methods - Data Integration Techniques - Data Cleaning and Preprocessing - Data Transformation - Feature Engineering and Selection - Data Encoding - Data Quality Assessment and Integration

UNIT II: Predictive Analytics for Business (15 Hours)

Regression Analysis - Classification Techniques - Model Evaluation Metrics- Overfitting and Underfitting in Predictive Models - Hyperparameter Tuning and Model Selection - Feature Importance and Interpretability in Business Contexts

UNIT III: Machine Learning Applications in Business (15 Hours)

Customer Segmentation and Market Basket Analysis - Sales Forecasting and Demand Prediction - Churn Prediction and Retention Models - Recommendation Systems - Fraud Detection and Risk Modeling - Sentiment Analysis on Social Media Data - NLP for Business Applications

UNIT IV: Advanced Data Analysis and Visualization (15 Hours)

Advanced Visualization Techniques - Interactive Dashboards for Business Insights - Time Series Analysis and Forecasting - Geospatial Data Analysis - Multivariate Analysis

UNIT V: Real-world Industry Applications and Capstone Projects (15 Hours)

Data Science in Healthcare – Retail - Financial Services - Manufacturing - E-commerce. **Capstone Projects:** Real-world Business Problem Solving Using Data Science - Data Collection, Preprocessing, Analysis, and Model Building - Model Deployment and Business Impact Analysis

Teaching Methodology	Lecture, Hands on
Assessment Methods	Snap Test, Assignment and Project work

Books for Study:

1. Provost, F., & Fawcett, T. (2013). Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking. O'Reilly Media.
2. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2014). Mining of Massive Datasets. Cambridge University Press.

Books for Reference:

1. VanderPlas, J. (2016). Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media.
2. Müller, A. C., & Guido, S. (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media.
3. Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer.
4. Raschka, S., & Mirjalili, V. (2019). Python Machine Learning: Machine Learning and Deep Learning with Python, Scikit-Learn, and TensorFlow 2. Packt Publishing.

Websites and eLearning Sources:

1. https://www.kaggle.com
2. https://towardsdatascience.com

3. https://www.datacamp.com

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Identify data collection and integration techniques.	**K1**
CO2	Apply data preprocessing methods like transformation and encoding.	**K2**
CO3	Use regression and classification for business analytics.	**K3**
CO4	Evaluate model performance and handle overfitting / underfitting.	**K4**
CO5	Build machine learning models for business problems.	**K5**
CO6	Analyze data and create interactive dashboards to present insights.	**K6**

Semester	Course Code	Title of the Course	Hours / Weeks	Credits
4	25PDS4ES03A	**Discipline Specific Elective - 3:** Business Analytics	4	3

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)

IntroductiontoBusinessAnalytics-BusinessAnalyticsProcess-IdentifyingData-Typesand 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
Assessment Methods	MCQ, Assignment, Seminar

Books for Study:

1. Bhimasankaram Pochiraju, Sridhar Seshadri. (2019). Essentials of Business Analytics. (1st ed.). Springer.
2. Dinabandhu Bag. (2016). Business Analytics. (1st ed.). Routledge.
3. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey. (2022). Business Analytics Principles, Concepts, and Applications: What, Why, and How. (1st ed.). Pearson Education.
4. David Stephenson. (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. Bernard Marr. (2017). Data Strategy: How to Profit from a World of Big Data, Analytics and the Internet of Things. Kogan Page Publishers.
2. Hardoon, David Roi, and Galit Shmueli. (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. 2.https://www.simplilearn.com/tutorials/business-analysis-tutorial
3. https://online.hbs.edu/blog/post/prescriptive-analytics

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Recall the fundamental components and stages of the business analytic sprocess 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**
4	**25PDS4ES03A**		**Discipline Specific Elective - 3:** Business Analytics						**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	Credits
4	25PDS4ES03B	**Discipline Specific Elective - 3:** Health Analytics	4	3

Course Objectives
To understand the basic sources of healthcare data.
To perform image analysis and sensor data analysis.
To derive and evaluate data mining and analysis from social media.
To frame advanced data analytic models through visual analytics.
To identify fraud detection in healthcare from different sources of data.

UNIT I: Basic Concepts **(12 Hours)**

Introduction to Healthcare Data Analytics Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR Barrier to Adopting HER Challenges Phenotyping Algorithms

UNIT II: Image Analysis **(12 Hours)**

Biomedical Image Analysis- Mining of Sensor Data in Healthcare- Biomedical Signal Analysis Genomic Data Analysis for Personalized Medicine.

UNIT III: NLP and Data Mining **(12 Hours)**

Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical Social Media Analytics for Healthcare.

UNIT IV: Visual Analytics **(12 Hours)**

Advanced Data Analytics for Healthcare– Review of Clinical Prediction Models- Temporal Data Mining for Healthcare Data- Visual Analytics for Healthcare- Predictive Models for Integrating Clinical and Genomic Data Information Retrieval for Healthcare- Data Publishing Methods in Healthcare.

UNIT V: Case Study **(12 Hours)**

Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries Clinical Decision Support Systems- Computer Assisted Medical Image Analysis Systems Mobile Imaging and Analytics for Biomedical Data.

Teaching Methodology	Instructive method, Problem solving, Group Discussion
Assessment Methods	MCQ, Assignment, Slip test

Books for Study:

1. Chandan K Reddy and Charu C Aggarwal. (2015). *Healthcare data analytics*. Taylor & Francis.
2. Ross M Muller and Edward M Rafalski. (2020). *Healthcare Analytics*. T&F Routledge.
3. Chandan K Reddy. (2020). *Healthcare Data Analytics*. CRC Press.
4. Vikas Kumar. (2020). *Healthcare Analytics made simple*. Packt.

Books for Reference:

1. Hui Yang and Eva K Lee. (2016). *Healthcare Analytics: From Data to Knowledge to Healthcare Improvement.* Wiley.
2. Tim O'reilly. (2022). *How data science is transforming Healthcare*. O'reilly.
3. Laura B Madsen. (2022). *Data driven healthcare*. Wiley.
4. Jason Burke. (2020). *Health Analytics*. Wiley.

Websites and eLearning Sources:

1. https://www.coursera.org/in/articles/healthcare-analytics
2. 2.https://www.merative.com/healthcare-analytics
3. https://nhsrcindia.org/health-data-analytics

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
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	Analyse 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**
4	**25PDS4ES03B**		**Discipline Specific Elective - 3:** Health Analytics							**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 /Weeks	Credits
4	**25PDS4CE01**	Comprehensive Examination	**0**	**2**

Course Objectives
To understand the basics of discrete mathematics and its use in data science.
To learn Python programming for data analysis and machine learning.
To explore machine learning, big data analytics, and deep learning techniques.
To study statistical methods and probability for data science.
To learn about cloud computing, artificial intelligence, and analytics in decision-making.

UNIT I:
Mathematics for Data Science - Discrete Mathematics

UNIT II:
Python Programming

UNIT III:
Machine Learning – Big data Analytics - Deep Learning

UNIT IV:
Statistics–I - Statistics– II

UNIT V:
Cloud Computing – Artificial Intelligence – Analytics

Teaching Methodology	Self - Study
Assessment Methods	MCQ

Books for Study:

1. Rosen, K. H. (2012). *Discrete Mathematics and Its Applications* (7th ed.). McGraw-Hill.
2. Lutz, M. (2013). *Learning Python* (5th ed.). O'Reilly Media.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning.* MIT Press.
4. Wackerly, D., Mendenhall, W., & Scheaffer, R. L. (2007). *Mathematical Statistics with Applications* (7th ed.). Thomson Brooks/Cole.
5. Rajkumar Buyya, James Broberg, & Andrzej Goscinski (2011). *Cloud Computing: Principles and Paradigms.* Wiley.

Books for Reference:

1. Grimaldi, R. P. (2013). *Discrete and Combinatorial Mathematics: An Applied Introduction* (5th ed.). Pearson.
2. Müller, A. C., & Guido, S. (2016). *Introduction to Machine Learning with Python: A Guide for Data Scientists.* O'Reilly Media.
3. VanderPlas, J. (2016). *Python Data Science Handbook: Essential Tools for Working with Data.* O'Reilly Media.
4. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2011). *Introduction to Probability and Statistics* (14th ed.). Brooks/Cole.

Websites and eLearning Sources:

1. https://www.kaggle.com
2. https://towardsdatascience.com
3. https://www.datacamp.com
4. https://www.coursera.org
5. https://www.edx.org

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-levels)**
On successful completion of this course, students will be able to		
CO1	Identify mathematical concepts relevant to data science.	**K1**
CO2	Apply Python programming techniques to solve real-world data problems.	**K2**
CO3	Use machine learning algorithms and deep learning models for data analysis.	**K3**
CO4	Analyze data using statistical methods and apply them to business and scientific contexts.	**K4**
CO5	Understand cloud computing principles and artificial intelligence technologies.	**K5**
CO6	Develop business insights through the application of analytics techniques.	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**25PDS4CE01**	Comprehensive Examination								**0**	**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
Mean Overall Score											2**.3 (High)**