PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR SALEM 636 011

MASTER OF SCIENCE IN DATA SCIENCE

SEMESTER PATTERN

Under Choice Based Credit System

REGULATIONS AND SYLLABUS

FOR AFFILIATED COLLEGES

(Effective from the Academic year 2023 - 2024 onwards)

CONTENTS

PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR SALEM 638 011

Regulations
Effective from the Academic year 2023 - 2024

i) OBJECTIVE OF THE COURSE

To Develop the Post Graduate in Data Science with strong knowledge of theoretical Data Science and who can be employed in research and development units of industries and academic institutions.

ii) CONDITIONS FOR ADMISSION

A candidate who has passed in B.Sc Computer Science / B.C.A / B.Sc Computer Technology / B.Sc Information Science / B.Sc Information Technology / B.Sc Data Analytics / B.Sc Data Science / B.Sc Artificial Intelligence and Data Science / B.Sc Cyber Security / B.Sc Internet of Things degree of this University or any of the degree of any other University accepted by the syndicate as equivalent thereto subject to such conditions as may be prescribed therefore shall be permitted to appear and qualify for the M.Sc Data Science degree examination of this University after a course of study of two academic years.

iii) DURATION OF THE COURSE

The programme for the degree of Master of Science in Data Science shall consist of two Academic years divided into four semesters.

iv) EXAMINATIONS

The examination shall be of three hours duration for each course at the end of each semester. The candidate failing in any subject(s) will be permitted to appear in the subsequent examination.

The practical / project should be an individual work. The University examination for practical / project work will be conducted by the internal and external examiners jointly at the end of each semester.

v) PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES DESCRIPTION

Programme	M.Sc., Data Science
Programme Code	PGCS-DS
Duration	**PG - Two Years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking,

problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

PSO3 – Research and Development
Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.

PSO4 – Contribution to Business World
To produce employable, ethical and innovative professionals to sustain in the dynamic business world.

PSO 5 – Contribution to the Society
To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

vi) METHODS OF EVALUATION & METHODS OF ASSESSMENT

METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test – 10 Marks	**25 Marks**
	Assignments / Snap Test / Quiz – 5 Marks	
	Seminars – 5 Marks	
	Attendance and Class Participation – 5 Marks	
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**
METHODS OF ASSESSMENT		
Remembering (K1)	• The lowest level of questions require students to recall information from the course content • Knowledge questions usually require students to identify information in the text book.	
Understanding (K2)	• Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. • The questions go beyond simple recall and require students to combine data together	
Application (K3)	• Students have to solve problems by using / applying a concept learned in the class room. • Students must use their knowledge to determine a exact response.	
Analyze (K4)	• Analyzing the question is one that asks the students to break down something into its component parts. • Analyzing requires students to identify reasons cause or motives and reach conclusions or generalizations.	
Evaluate (K5)	• Evaluation requires an individual to make judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged in decision-making and problem – solving. • Evaluation questions do not have single right answers.	

Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem solving skills

vii) PROGRAMME OUTCOMES (PO) - PROGRAMME SPECIFIC OUTCOMES (PSO) MAPPING

PROGRAMME SPECIFIC OUTCOMES (PSO)					
	PO1	PO2	PO3	PO4	PO5
PSO1	3	3	3	3	3
PSO2	3	3	3	3	3
PSO3	3	3	3	3	3
PSO4	3	3	3	3	3
PSO5	3	3	3	3	3

Level of Correlation between PO's and PSO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value
1 – Low
2 – Medium
3 – High
0 – No Correlation

viii) STRUCTURE OF M. Sc (DATA SCIENCE) PROGRAMME

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	EA	Total
FIRST SEMESTER							
23PDS01	Core I: Fundamentals of Data Science	5	7	-	25	75	100
23PDS02	Core II: Mathematics for Data Science	5	7	-	25	75	100
23PDS03	Core III: Statistics-I	4	6	-	25	75	100
23PDSE0_	Elective I	3	5	-	25	75	100
23PDSE0_	Elective II	3	3	2	25	75	100
	Total	20	30				
SECOND SEMESTER							
23PDS04	Core IV: Python Programming	5	5	-	25	75	100
23PDSP01	Core Lab I: Python Programming Lab	5	-	6	40	60	100
23PDS05	Core V: Statistics-II	4	5	-	25	75	100
23PDSE0_	Elective III	3	4	-	25	75	100
23PDSE_ _	Elective IV	3	4	-	25	75	100
23PDSSP0_	Skill Enhancement Course-SEC	2	4	-	40	60	100
23PHR01	Fundamentals of Human Rights	1	2		25	75	100
	Total	23	30				

	THIRD SEMESTER						
23PDS06	Core VI: Machine Learning	5	6	-	25	75	100
23PDSP02	Core Lab II: Machine Learning Lab	5	-	6	40	60	100
23PDS07	Core VII: Databases for Data Science	5	6	-	25	75	100
23PDS08	Core VIII: Core Industry Module Suggestive topics: 1. Business Analytics 2. Health care Analytics 3. Financial Analytics	4	6	-	25	75	100
23PDSE_ _	Elective V	3	3	-	25	75	100
23PDSIT1	Internship/Industrial Activity	2	-	-			
23PDSSEC01	Skill Enhancement Course-Professional Communication Skill - Term paper & Seminar presentation	2		3	25	75	100
	Total	26	30				
	FOURTH SEMESTER						
23PDS09	Core IX: Cloud Computing	5	6	-	25	75	100
23PDS10	Core X: Big Data Analytics	3	3	-	25	75	100
23PDSP03	Core Lab III: Big Data Analytics Lab	2	-	3	40	60	100
23PDSE_ _	Elective VI	3	4		25	75	100
23PDSPR1	Core XI: Project with Viva Voce	7	10		20	80	100
23PDSPC0_	Professional competency Skill Enhancement Course	2		4	40	60	100
23PDSEX01	Extension Activity	1	-	-			
	Total	23	30				
	Grand Total	92					

ix) ELECTIVES LIST

Elective Course–I

23PDSE01   Research Methodology for Computer Science
23PDSE02   Data Structures & Algorithms
23PDSE03   Internet of Things

Elective Course–II

23PDSE04   Web Programming
23PDSE05   Java Programming
23PDSE06   Operating Systems(Linux Based Commands for Practicals)

Elective Course–III

23PDSE07   Information Security and Ethics
23PDSE08   Distributed Systems
23PDSE09   Software Engineering for Data Science

Elective Course–IV

23PDSE10   Applied Probability
23PDSE11   Optimisation Techniques
23PDSE12   Discrete Mathematics

Elective Course–V

23PDSE13   Natural Language Processing
23PDSE14   Reinforcement Learning
23PDSE15   Social Network Analysis

Elective Course–VI

23PDSE16   Artificial Intelligence and Data Science
23PDSE17   Image Recognition
23PDSE18   Deep Learning

x) SKILL ENHANCEMENT COURSES LIST (SEC)

23PDSSP01   Cloud Computing – Lab
23PDSSP02   Digital Image Processing Lab using MATLAB

xi) PROFESSIONAL COMPETENCY SKILL ENHANCEMENT COURSE LIST (ANY ONE)

23PDSPC01   Soft Skill Development Lab
23PDSPC02   Data Visualization Lab

xii) EDC-EXTRA DISCIPLINARY COURSE LIST

Students are expected to opt EDC (Non major elective) offered to other departments.

23PDSED01   Principles of Information Technology
23PDSED02   Fundamentals of Computers and Communications
23PDSED03   E-Commerce

xiii) EXTERNAL ASSESSMENT QUESTION PAPER PATTERN (THEORY)

Time: 3 Hours   Max. Marks: 75

PART- A: 15x1 = 15 marks
Answer all the questions
Three questions from each unit (Multiple Choice Questions)

PART- B: 2x5 = 10 marks
Answer any TWO questions
One question from each unit

PART- C: 5x10 = 50 marks
Answer all the questions
One question from each unit (either or type)

The Passing minimum shall be 50% out of 75 marks (38 marks)

xiv) CONTINUOUS INTERNAL ASSESSMENT FOR PRACTICAL

Test1 :   15 Marks
Test2 :   15 Marks
Record: 10 Marks
- - - - - - - - - -- - - - - -
Total   :   40 Marks
- - - - - - - - - - - - - --

(Record Note must be compulsorily submitted while attending the Practical Examination and No passing minimum)

xv) EXTERNAL ASSESMENT QUESTION PAPER PATTERN (PRACTICAL)

Exam duration: 3 Hours   Max. Marks:60

There will be two questions with or without subsections to be given for the practical examination. Every question should be chosen from the question bank

prepared by the examiner(s).

Distribution of Marks

Each question	: 30 Marks
Problem Understanding	: 05 Marks
Program writing	: 10 Marks
Debugging	: 10 Marks
For Correct Results	: 05 Marks

xvi) ASSESSMENT OF PROJECT WORK

Continuous Internal Assessment	: 50 Marks
Review I	: 25 Marks
Review II	: 25 Marks
External Assessment:	
Evaluation & Viva-Voce (Jointly)	: 150 Marks

> **Common instruction for the project work**
> - The Candidate should submit the filled in format as given in Annexure-I to the department for approval during the 1st Week of IV Semester.
> - Periodically the project should be reviewed.
> - The Student should submit three copies of their Project work.
> - A Sample format is enclosed in Annexure-II.
> - Format of the Title page and Certificate are enclosed in Annexure-III.
> - The students may use power point presentation during their viva voce examination.

xvii) PASSING MINIMUM

The candidate shall be declared to have passed in the Theory / Practical / Project Work examination, if the candidate secures not less than 50% marks in EA and also in total of the prescribed marks. However submission of a record note book is a must.

xviii) CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who obtain 75% and above in the aggregate shall be deemed to have passed the examination in **First Class with Distinction** provided they pass all the examinations prescribed for the programme at the first appearance. Candidates, other than the above, who secure not less than 60% of the aggregate marks in the whole examinations, shall be declared to have passed the examination in **First Class**. The remaining successful candidates shall be declared to have passed in **Second Class**.

Candidates who pass all the examinations prescribed for the programme in first instance and within a period of two academic years from the year of admission are only eligible for **University Ranking.**

xix) MAXIMUM DURATION FOR THE COMPLETION OF THE PROGRAMME

The maximum duration to complete the programme shall be three academic years after normal completion of the programme.

xx) COMMENCEMENT OF THIS REGULATION

These regulations shall take effect from the academic year 2023-24, that is, for students who are admitted to the first year of the programme during the academic year 2023-24 and thereafter.

PERIYAR UNIVERSITY

Name of the College   :

Programme   :

Name of the Student   :

Register Number   :

Title of the Project Work   :

Address of Organization / Institution :

Name of the External Guide   :

Designation   :

Place :

Date: Signature of External Guide

                                                           (With seal)

Name of the Internal Guide   :

Qualification   :

Teaching Experience   :

Place :

Date: Signature of Internal Guide

CONTENTS

A. Format of the title page

TITLE OF THE PROJECT WORK

A Project work submitted in partial fulfilment of the requirements for the degree

of

Master of Science in Data Science

to the

Periyar University, Salem – 11

Submitted by

Name of the Student

Reg. No.

Under the Guidance of

**Name of the guide
(Designation, Name of the department)**
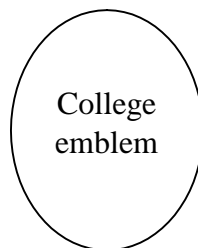
College
emblem

Name of the Department

College Name

(Affiliated to Periyar University)

Place with Pin Code

Month – Year

B. Format of the Certificate

<div align="center">

College Name

(Affiliated to Periyar University)

Place with Pin Code

</div>

College
emblem
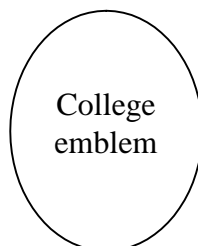
This is to certify that the Project Work entitled **Title of the Project** submitted in partial fulfilment of the requirements of the degree of Master of Science in Data Science to the Periyar University, Salem is a record of bonafide work carried out by **Name of the student** Reg. No._____ under my supervision and guidance.

Head of the Department   **Internal Guide**

Submitted for Viva-Voce Examinations held on _____ at Name of the college, Place with pin code.

External Examiner   **Internal Examiner**

Title of the Course	FUNDAMENTALS OF DATA SCIENCE					
Paper Number	**CORE I**					
Category Core	**Year**	I	**Credits**	4	**Course Code**	**23PDS01**
	Semester	I				
Instructional Hours per week	**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
	4		1	--	5	
Pre-requisite	Basic understanding of data and process					
Objectives of the Course	To introduce the concepts and fundamentals of data science and its life cycle					
Learning Outcome	Students will be able to **CO1 :** Understand the types of data and analytics , data science process, and its life cycle. **CO 2:** Apply math in data science **CO 3:** Analyze the various data intensive operations and tools **CO 4:** Evaluate the tools and methods for analyzing the data **CO 5:** Investigate the recent potential applications and development of data science with real time case studies					
Course Outline	**UNIT-I: INTRODUCTION OF DATA SCIENCE** Data Science – Data science Venn diagram - Basic terminology – Data science case studies- Types of data – levels of data- Types of data analytics - Descriptive Analytics-Diagnostic analytics-Predictive analytics- Prescriptive analytics- Five steps of Data science **Book 1 - Chapter 1,2,3**					
	UNIT-II: MATHEMATICAL PRELIMINARIES 2.1 Basic Maths – mathematics as discipline – basic symbols and terminology –linear algebra 2.2 Basic Probability – definitions- probability – Bayesian vs frequentist – compound events – conditional probability – rules of probability **Book 1: Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5**					
	UNIT-III: DATA MINING AND DATA WAREHOUSING Introduction to Data warehousing – Design consideration of data warehouse - Data loading process – case study – Data mining – Data mining techniques – Tools and platforms – case study **Book 2 – Chapter 3 and 4**					
	UNIT-IV : VISUALIZING DATA Exploratory Data Analysis – Developing the visual aesthetic – chart types – Great visualizations – Reading graphs – Interactive visualizations **Book 3 - Chapter 6**					

	UNIT-V: Data Science – Recent Trends Applications of Data Science, recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Data Science Process, Fundamentals, Applications
Recommended Text	1. Ozdemir, Sinan. Principles of data science. Packt Publishing Ltd, 2016.(Unit 1- Chapter 1,2,3 Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5) 2. Maheshwari, Anil. "Data analytics made accessible." Seattle: Amazon Digital Services, 2 nd edition (2023).(Unit 3 – Chapter 3 and 4) 3. Skiena, Steven S. The data science design manual. Springer, 2017.(Unit 4- chapter 6)
Reference Books	1. Hadrien Jean.Education, C. (2023). Data Science. Certybox Education. 2. Pierson, Lillian. Data science for dummies. John Wiley & Sons, 2021. 3. Grus, Joel. Data science from scratch: first principles with python. O'Reilly Media, 2019. 4. Blum, Avrim, John Hopcroft, and Ravindran Kannan. Foundations of data science. Cambridge University Press, 2020.
Website and e-Learning Source	https://www.analyticsvidhya.com/ https://www.simplilearn.com https://www.ibm.com/in-en/topics/data-science https://www.mygreatlearning.com/blog/what-is-data-science/

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	3
Weightage of course contributed to each PSO	15	10	12	15	15	13

Title of the Course	**MATHEMATICS FOR DATA SCIENCE**					
Paper Number	**CORE II**					
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PDS02**
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**
		4		1	--	5
Pre-requisite		UG level Mathematics				
Objectives of the Course		To build the mathematical background necessary to understand and implement in data science practical/research work				
Learning Outcome		Students will be able to **CO1:** Demonstrate understanding of basic mathematical concepts in data science, relating to linear algebra **CO2:** Describe properties of linear systems using vectors, perform and interpret matrix operations. **CO3:** Describe and compute orthogonality and determinants **CO4:** Solve linear differential equations **CO5:** Understand and apply the concept of Linear transformations				
Course Outline		**UNIT-I:** **1.1 Vectors and Matrices** Vectors and Linear Combinations-Lengths and Angles from Dot Products-Matrices and Their Column Spaces-Matrix Multiplication AB and CR **1.2 Solving Linear Equations Ax = b** Elimination and Back Substitution-Elimination Matrices and Inverse Matrices-Matrix Computations and A = LU-Permutations and Transposes				
		UNIT-II: **2.2 The Four Fundamental Subspaces** Vector Spaces and Subspaces-Computing the Nullspace by Elimination: A = CR-The Complete Solution to Ax = b-Independence, Basis, and Dimension-Dimensions of the Four Subspaces				
		UNIT-III: **3.1 Orthogonality** Orthogonality of Vectors and Subspaces-Projections onto Lines and Subspaces-Least Squares Approximations-Orthonormal Bases and Gram-Schmidt-The Pseudoinverse of a Matrix **3.2 Determinants** 3 by 3 Determinants and Cofactors-Computing and Using Determinants-Areas and Volumes by Determinants				

	UNIT-IV :
	4.1 Eigenvalues and Eigenvectors
	Introduction to Eigenvalues : $Ax = \lambda x$ - Diagonalizing a Matrix-Symmetric Positive Definite Matrices-Complex Numbers and Vectors and Matrices-Solving Linear Differential Equations
	UNIT-V:
	5.1 The Singular Value Decomposition (SVD)
	Singular Values and Singular Vectors-Image Processing by Linear Algebra-Principal Component Analysis (PCA by the SVD)
	5.2 Linear Transformations
	The Idea of a Linear Transformation-The Matrix of a Linear Transformation-The Search for a Good Basis
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency
Recommended Text	[1] Gilbert Strang, Introduction to Linear Algebra, Wellesley - Cambridge Press, Sixth Edition, 2023
Reference Books	[1] David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications 5th Edition, Pearsons [2] Sheldon Axler, Linear Algebra Done Right (Undergraduate Texts in Mathematics) 3rd ed., Springer, 2015 Edition [3] Jim Hefferon, Linear Algebra, Fourth edition [4] Jeff M Philips, Mathematical Foundations for Data Analysis
Website and e-Learning Source	**https://joshua.smcvt.edu/linearalgebra/**

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	3	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
Weightage of course contributed to each PSO	15	13	11	15	15	15

Title of the Course	STATISTICS – I					
Paper Number	**CORE III**					
Category	Core	**Year**	I	**Credits**	4	**Course**	**23PDS03**
		Semester	I			**Code**	
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite		Basic Statistics					
Objectives of the Course		To develop knowledge and understand fundamental concepts in probability and statistics					
Learning Outcome		Students will be able to **CO1:** Organize, manage and present data. **CO2:** Understand, describe, and calculate the measures of data and correlation. **CO3**: Recognize and understand various probability distribution functions, calculate and interpret expected results **CO4:** Apply the methods of estimating a parameter. **CO5:** Understand the concept of probability and apply for simple events					
Course Outline		**UNIT-I:** **1.1 Introduction to Statistics** Introduction-Data Collection and Descriptive Statistics-Inferential Statistics and Probability Models-Populations and Samples-A Brief History of Statistics **1.2 Organization and Presentation of Data** Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions					
		UNIT-II: **2.1 Descriptive statistics** Introduction-Describing Data Sets-Frequency Tables and Graphs-Relative Frequency Tables and Graphs-Grouped Data, Histograms, Ogives, and Stem and Leaf Plots-Summarizing Data Sets-Sample Mean, Sample Median, and Sample Mode-Sample Variance and Sample Standard Deviation-Sample Percentiles and Box Plots-Chebyshev's Inequality-Normal Data Sets-Paired Data Sets and the Sample Correlation Coefficient **2.2 Correlation** Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).					

	UNIT-III:
	3.1 Random variables and expectation
	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
	3.2 Special random variables
	The Bernoulli and Binomial Random Variables-Computing the Binomial Distribution Function-The Poisson Random Variable-Computing the Poisson Distribution Function-The Hypergeometric Random Variable-The Uniform Random Variable- Normal Random Variables-Exponential Random Variables-The Poisson Process-The Gamma Distribution-Distributions Arising from the Normal-The Chi-Square Distribution-The t-Distribution-The F Distribution-The Logistics Distribution
	UNIT-IV:
	4.1 Distributions of sampling statistics
	Introduction-The Sample Mean-The Central Limit Theorem-Approximate Distribution of the Sample Mean, How Large a Sample Is Needed?-The Sample Variance-Sampling Distributions from a Normal Population-Distribution of the Sample Mean, Joint Distribution of X and S-Sampling from a Finite Population
	4.2 Parameter estimation
	Introduction-Maximum Likelihood Estimators-Interval Estimates-Confidence Interval for a Normal Mean When the Variance is Unknown-Confidence Intervals for the Variance of a Normal Distribution - Estimating the Difference in Means of Two Normal Populations-Approximate Confidence Interval for the Mean of a Bernoulli Random Variable-Confidence Interval of the Mean of the Exponential Distribution-The Bayes Estimator
	UNIT-V :
	5.1 Basics and Elements of Probability
	Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye's theorem and its applications-Introduction-Sample Space and Events-Venn Diagrams and the Algebra of Events-Axioms of Probability-Sample Spaces Having Equally Likely Outcomes
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Sheldon M. Ross, Introduction to Probability and Statistics for Engineers And Scientists, Elsevier Academic Press, UK, Fifth Edition, 2023 [2]. Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015. [3]. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.
Reference Books	Jim Frost, Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries
Website and e-Learning Source	https://onlinestatbook.com/2/ https://www.simplilearn.com/tutorials/statistics-tutorial https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-data-analysts-69d93a05aae7

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	2	3	3	3
CO2	2	3	3	3	3	2
CO3	2	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3
Weightage of course contributed to each PSO	13	15	13	15	15	12

Title of the Course	**PYTHON PROGRAMMING**						
Paper Number	**CORE IV**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PDS04**
		Semester	II				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite	NA						
Objectives of the Course	To be able to think logically and develop interactive programs using the python constructs, functions, data structures, classes and objects, files.						
Learning Outcome	Students will be able to **CO 1:** Recall the components of a computer, demonstrate the appropriate use of data types, mathematical functions and strings in a program **CO 2:** State the use of selection and looping constructs, compare and choose an appropriate construct for a given problem **CO 3:** Define Functions, Classes and Objects, defend the use of functions, classes and objects in a given problem **CO 4:** Define Strings and Lists, implement Lists and Strings appropriately, design new problems using appropriate data structures **CO 5:** Define Tuples, sets, dictionaries and files, compare programs with and without files, develop applications using the different data structures						
Course Outline	**UNIT-I : Introduction to Computers, Programs and Python -** Introduction - Computer and its components - Programming Languages - Operating Systems - The history of Python - Introduction to python programming - Programming Style and Documentation - Programming Errors - Introduction to Graphics Programming **Chapter - 1** **Elementary Programming** - Input - Output - Identifiers - Variables, Assignment Statements and Expressions - Simultaneous Assignments - Named Constants - Numeric Data Types and Operators - Evaluating Expressions and Operator Precedence - Augmented Assignment Operators - Type Conversion and Rounding **Chapter - 2** **Mathematical Functions, Strings and Objects -** Introduction - Common Python Functions - Strings and Characters - Introduction to Objects and Methods - Formatting Numbers and Strings - Drawing various shapes with Colors and Fonts **Chapter – 3**						

	UNIT-II : Selections - Introduction - Boolean Types, Values and Expressions - Generating Random Numbers - Different forms of if statements - Logical Operators - Conditional Expressions - Operator Precedence and Associativity **Chapter - 4** **Loops** - Introduction - while, for , Nested Loops - break and Continue **Chapter – 5**
	UNIT-III : Functions - Introduction - Defining and calling a function - Return single and multiple values - Positional, Keyword and Default Arguments - Passing Arguments by Reference Values - Modularizing Code - Function Abstraction and Stepwise Refinement - Recursion **Chapter - 6, Chapter 15 - 15.1,15.2,15.4** **Objects and Classes -** Introduction - Defining Classes for Objects - UML Class Diagrams - Immutable vs Mutable Objects - Hiding Data Fields - Class Abstraction and Encapsulation - Object Oriented Thinking **Chapter - 7** **Inheritance and Polymorphism -** Superclasses and Subclasses - Overriding methods - Object class - Polymorphism and Dynamic binding **Chapter – 12**
	UNIT-IV : More on Strings and Special Methods - Introduction - Str class - Operator Overloading and Special Methods - **Chapter - 8** **Lists -** Basics - Copying Lists - Passing Lists to Functions - Returning a List from a Function - Searching, Sorting Lists - **Chapter 10** **Multidimensional Lists** - Processing Two - Dimensional Lists - Passing Two - Dimensional Lists to Functions - Multidimensional Lists **Chapter 10**
	UNIT-V: Tuples, Sets and Dictionaries – Introduction - Tuples - Sets - Comparing the Performance of Sets and Lists - Dictionaries - **Chapter - 14** **Files and Exception Handling** – Introduction - Text Input and Output - File Dialogs - Retrieving Data from Web - Exception Handling - Raising Exceptions - Processing Exceptions using Exception Objects - Defining Custom Exception Classes - Binary IO Using Pickling **Chapter – 13**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies related to the above topics given in the Text Book to be solved. (To be discussed during the Tutorial hour)
Skills acquired from this course	Problem Solving, Analytical ability, Professional Competency, Programming Knowledge
Recommended Text	Y. Daniel Lang, *Introduction to Programming using Python*, 2nd Edition, Pearson Education Inc., 2013.
Reference Books	1. Allen B. Downey. Think Python. How to Think Like a Computer Scientist, 2ndedition, O'Reilly Publishers, 2016. 2. Corey Wade, et al : *The Python Workshop*, 2nd Edition, Packt, 2022. 3. David Beazley, Brian K. Jones. Python Cookbook: Recipes for Mastering Python 3, 3rd Edition, 2013 Harsh Bhasin. Python for Beginners. New Age International Publishers,2018. 4. Martin C. Brown. Python: The Complete Reference. McGraw Hill Education; Fourth edition, 2018.
Website and e-Learning Source	https://realpython.com, http://docs.python.org, http://diveintopython.org/, https://www.w3schools.com/python/ , https://www.tutorialspoint.com/python/index.htm

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	2	3	3	3
CO2	2	3	3	3	3	2
CO3	2	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3
Weightage of course contributed to each PSO	13	15	13	15	15	12

Title of the Course	**PYTHON PROGRAMMING – LAB**						
Paper Number	**LAB I**						
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**23PDSP01**
		Semester	II				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		—		—	5	5	
Pre-requisite	NA						
Objectives of the Course	To be able to apply appropriately the python programming knowledge gained and develop computer based solutions for a given problem						
Learning Outcome	Students will be able to **CO 1:** Recall the components of a computer, demonstrate the appropriate use of data types, mathematical functions and strings in a program **CO 2:** State the use of selection and looping constructs, compare and choose an appropriate construct for a given problem **CO 3:** Develop modular programming using functions , Design program using OO constructs **CO 4:** Demonstrate Strings and Lists, implement Lists and Strings appropriately, design new problems using appropriate data structures **CO 5:** Demonstrate Tuples, sets, dictionaries and files, compare programs with and without files, develop applications using different data structures						
Course Outline	**UNIT-I :** 1. Installation of the required software 2. Programs using basic data types and operators 3. Programs involving Mathematical functions 4. Program in String Manipulations						
	UNIT-II : 1. Programs using different forms of if statement 2. Drawing various shapes using turtle 3. Programs involving repeated execution of a set of statements 4. Programs using break and continue 5. Programs using random						
	UNIT-III : 1. Modular programming using functions 2. Programs using positional, keyword and default argument 3. Programs using pass by value, pass by reference 4. Programs using classes and objects 5. Programs using Inheritance						
	UNIT-IV : 1. Programs on Str class and special methods 2. Programs using Lists and List manipulation 3. Programs using Two-Dimensional Lists						

	UNIT-V:
	1. Programs using Tuple and its methods
	2. Programs with Set and Set manipulation
	3. Programs using Dictionaries
	4. Program comparing the performance of Sets and Lists
	5. Programs handling Text Files
	6. Programs handling Binary Files
	7. Programs handling exceptions
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies related to the above topics given in the Text Book to be solved.
Skills acquired from this course	Problem Solving, Analytical ability, Professional Competency, Programming Knowledge
Recommended Text	Y. Daniel Lang, *Introduction to Programming using Python*, 2nd Edition, Pearson Education Inc., 2013.
Reference Books	1. Allen B. Downey. Think Python. How to Think Like a Computer Scientist, 2ndedition, O'Reilly Publishers, 2016.
	2. Corey Wade, et al : *The Python Workshop*, 2nd Edition, Packt, 2022.
	3. David Beazley, Brian K. Jones. Python Cookbook: Recipes for Mastering Python 3, 3rd Edition, 2013 Harsh Bhasin. Python for Beginners. New Age International Publishers,2018.
	4. Martin C. Brown. Python: The Complete Reference. McGraw Hill Education; Fourth edition, 2018.
Website and e-Learning Source	https://realpython.com, http://docs.python.org, http://diveintopython.org/, https://www.w3schools.com/python/ , https://www.tutorialspoint.com/python/index.htm

CO/ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	1	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	2
CO5	3	3	3	3	3	3
Weightage of course contributed to each PSO	15	15	11	15	15	14

Title of the Course	STATISTICS - II						
Paper Number	CORE V						
Category	Core	Year	I	Credits	4	Course Code	23PDS05
		Semester	II				
Instructional Hours per week	Lecture		Tutorial		Lab Practice		Total
	4		1		--		5
Pre-requisite	Statistics in Semester I						
Objectives of the Course	To develop knowledge and understand fundamental concepts in probability and statistics						
Learning Outcome	Students will be able to **CO1:** Identify the four steps of hypothesis testing. **CO2:** Gain a thorough understanding of applied principles of statistics. **CO3**: To develop knowledge and skills in theoretical, computational and application-oriented statistics **CO4:** Apply the methods of analysis of variance **CO5:** Understand and apply the concept of non-parametric tests						
Course Outline	**UNIT-I:** **1.1 INTRODUCTION** 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. **1.2 Hypothesis testing** Introduction-Significance Levels-Tests Concerning the Mean of a Normal Population-Case of Known Variance-Case of Unknown Variance: The t-Test-Testing the Equality of Means of Two Normal Populations-Case of Known Variances-Case of Unknown Variances-Case of Unknown and Unequal Variances-The Paired t-Test- Hypothesis Tests Concerning the Variance of a Normal Population-Testing for the Equality of Variances of Two Normal Populations-Hypothesis Tests in Bernoulli Populations-Testing the Equality of Parameters in Two Bernoulli Populations-Tests Concerning the Mean of a Poisson Distribution-Testing the Relationship Between Two Poisson Parameters						
	UNIT-II: **2.1 Hypothesis Testing-II** 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) – chisquare test for independence of attributes – Chi-square test for goodness of fit.						

	UNIT-III:
	3.1 Regression
	Introduction-Least Squares Estimators of the Regression Parameters-Distribution of the Estimators-Statistical Inferences About the Regression Parameters-Inferences Concerning β - Inferences Concerning α- Inferences Concerning the Mean Response $\alpha+\beta x 0$ - Prediction Interval of a Future Response-Summary of Distributional Results- 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:
	4.1 Analysis of variance
	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 ParameterEstimation-Two-Factor Analysis of Variance: Testing Hypotheses-Two-Way Analysis of Variance with Interaction
	4.2 Goodness of fit tests and categorical data analysis
	Introduction-Goodness of Fit Tests When All Parameters Are Specified-Determining the Critical Region by Simulation-Goodness of Fit Tests When Some Parameters Are Unspecified-Tests of Independence in Contingency Tables -Tests of Independence in Contingency Tables Having Fixed Marginal Totals-The Kolmogorov–Smirnov Goodness of Fit Test for Continuous Data
	UNIT-V :
	5.1 Nonparametric hypothesis tests
	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.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency

Recommended Text	[1] Sheldon M. Ross, Introduction to Probability and Statistics for Engineers And Scientists, Elsevier Academic Press, UK, Fifth Edition, 2023 [2] Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 12th edition, Sultan Chand & Sons, New Delhi, 2020. [3] Brian Caffo, Statistical Inference for Data Science, Learnpub, 2016.
Reference Books	[1] Allen B. Downey, Think Stats- Exploratory data analysis, O'reilly, 2nd Edition [2] Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Publications, Tenth Edition [3] Jim Frost, Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries
Website and e-Learning Source	https://onlinestatbook.com/2/ https://www.simplilearn.com/tutorials/statistics-tutorial https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-data-analysts-69d93a05aae7

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	1	1	2	2
CO2	3	3	2	2	2	2
CO3	3	2	2	3	2	2
CO4	3	2	2	2	2	3
CO5	3	3	2	3	2	3
Weightage of course contributedto each PSO	14	13	9	11	10	12

23PHR01 - Fundamentals of Human Rights

Unit I: Introduction:

Meaning and Definitions of Human Rights – Characteristics and Importance of Human Rights – Evolution of Human Rights – Formation, Structure and Functions of the UNO - Universal Declaration of Human Rights – International Covenants – Violations of Human Rights in the Contemporary Era.

Unit II: Human Rights in India:

Development of Human Rights in India – Constituent Assembly and Indian Constitution – Fundamental Rights and its Classification – Directive Principles of State Policy – Fundamental Duties.

Unit III:

Rights of Marginalized and other Disadvantaged People: Rights of Women – Rights of Children – Rights of Differently Abled – Rights of Elderly - Rights of Scheduled Castes – Rights of Scheduled Tribes – Rights of Minorities – – Rights of Prisoners – Rights of Persons Living with HIVAIDS – Rights of LGBT.

Unit IV:

Human Rights Movements: Peasant Movements (Tebhaga and Telangana) – Scheduled Caste Movements (Mahar and Ad-Dharmi) – Scheduled Tribes Movements (Santhal and Munda) – Environmental Movements (Chipko and Narmada BachaoAndolan) – Social Reform Movements (Vaikom and Self Respect).

Unit V:

Redressal Mechanisms: Protection of Human Rights Act, 1993 (Amendment 2019) – Structure and Functions of National and State Human Rights Commissions – National Commission for SCs – National Commission for STs – National Commission for Women – National Commission for Minorities – Characteristics and Objectives of Human Rights Education.

References

1. SudarshanamGankidi, Human Rights in India: Prospective and Retrospective, Rawat Publications, Jaipur, 2019.

2. SatvinderJuss, Human Rights in India, Routledge, New Delhi, 2020.

3. Namita Gupta, Social Justice and Human Rights in India, Rawat Publications, Jaipur, 2021.

4. Mark Frezo, The Sociology of Human Rights, John Willy & Sons, U.K. 2014.

5. Chiranjivi J. Nirmal, Human Rights in India: Historical, Social and Political Perspectives, Oxford University Press, New York, 2000.

6. Dr. S. Mehartaj Begum, Human Rights in India: Issues and perspectives, APH Publishing Corporation, New Delhi, 2010.

7. Asha Kiran, The History of Human Rights, Mangalam Publications, Delhi, 2011.

8. Bani Borgohain, Human Rights, Kanishka Publishers & Distributors, New Delhi-2, 2007.

9. Jayant Chudhary, A Textbook of Human Rights, Wisdom Press, New Delhi, 2011.

Title of the Course	MACHINE LEARNING						
Paper Number	CORE VI						
Category	Core	Year	II	Credits	4	Course Code	23PDS06
		Semester	III				
Instructional Hours per week		Lecture		Tutorial	Lab Practice		Total
		4		1	--		5
Pre-requisite		Basic Programming Skill and Data Knowledge					
Objectives of the Course		To understand the different types, steps and algorithms involved in Machine Learning Process					
Learning Outcome		**CO1:** Describe the data, essential steps for creating a typical ML model and the fundamentals of pattern classification **CO2:** Able to examine different ML algorithms and unprocessed data and features **CO3:** Implement the essential techniques to reduce the number of features in a dataset and test the performance of predictive models **CO4:** Select multiple algorithms, combine and produce ensembles, discuss the essential techniques for modeling linear relations **CO5:** Discuss the clustering algorithms, develop a Web application embedding a ML model					

Course Outline	**UNIT-I : Data Analytics with pandas and NumPy -** NumPy and basic stats - Matrices - pandas library - Working with data - Null Values - Creating statistical graphs
	Book 1, Chapter -10
	Giving Computers the ability to learn from data - Introduction - Building intelligent systems to transform data into knowledge - The three different types of Machine Learning(ML) - Introduction to basic terminology and notations - A roadmap for building ML systems - Using Python for ML
	Book 2, Chapter - 1
	Training Simple ML Algorithms for Classification - Early History of ML - Implementing a Perceptron learning algorithm - Adaptive linear neurons and the convergence of learning
	Book 2, Chapter - 2
	UNIT-II : ML Classifiers using sckikit-learn - Choosing a classification algorithm - Training a perceptron - Modeling class probabilities via logistic regression - Maximum margin classification with support vector machines(SVM) - Solving nonlinear problems using a kernel SVM - Decision tree learning - K-nearest neighbours: a lazy learning algorithm
	Book 2 , Chapter 3
	Data Preprocessing - Missing data - Categorical data - Partitioning a dataset into separate training and test datasets - Bringing features onto the same scale - Selecting meaningful features - Assessing feature importance with random forests
	Book 2, Chapter - 4

	UNIT-III : Compressing Data via Dimensionality Reduction - Unsupervised dimensionality reduction via principal component analysis - Supervised data compression via linear discriminant analysis - Using kernel principal component analysis for nonlinear mappings **Book 2, Chapter - 5** **Learning Best Practices for Model Evaluation and Hyperparameter Tuning -** Streamlining workflows with pipelines - Using k-fold cross-validation to assess model performance - Debugging algorithms with learning and validation curves - Fine-tuning ML models via grid search - Looking at different performance evaluation metrics **Book 2, Chapter - 6**
	UNIT-IV : Combining different models for ensemble learning - Learning with ensembles - Combining classifiers via majority vote - Bagging: building an ensemble of classifiers from bootstrap samples - Leveraging weak learners via adaptive boosting **Book 2, Chapter - 7** **Predicting Continuous Target Variables with Regression Analysis - Introducing Linear regression -** Implementing an ordinary least squares linear regression model - Fitting a robust regression model using RANSAC - Evaluating the performance of linear regression models - Using regularised methods for regression - Turning a linear regression model into a curve -polynomial regression - Dealing with nonlinear relationships using random forests **Book 2, Chapter - 10**
	UNIT-V: Working with Unlabelled Data – Grouping objects by similarity using k-means - Organising clusters as a hierarchical tree - Locating regions of high density via DBSCAN **Book 2, Chapter - 11** **Introduction to Embedding a ML model into a Web Application -** Serialising fitted scikit-learn estimators - Setting up an SQLite database for data storage - Developing a web application with Flask - Turning any classifier into a web application - Deploying the web application to a public server **Book 2, Chapter - 9**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Mini project applying ML concepts in existing / real time data
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019
Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://data-flair.training/blogs/machine-learning-tutorial/ 2. https://www.geeksforgeeks.org/machine-learning/

Course Outcome

Upon completion of the course, the student will be able to

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	2	2
CO2	3	3	2	3	3	2
CO3	3	2	3	2	3	3
CO4	3	2	3	2	3	3
CO5	3	3	3	3	3	3
Weightage of course contributed to eachPSO	**15**	**13**	**13**	**12**	**14**	**13**

Title of the Course	MACHINE LEARNING - LAB						
Paper Number	LAB II						
Category	Core	Year	II	Credits	4	Course Code	23PDSP02
		Semester	III				
Instructional Hours per week	Lecture		Tutorial	Lab Practice		Total	
	—		1	5		5	
Pre-requisite	Basic Programming Skill and Data Knowledge						
Objectives of the Course	To preprocess the data and build ML models using appropriate techniques and evaluate the model						
Learning Outcome	Upon completion of the course, the student will be able to **CO1:** Apply pandas, NumPy and Matplotlib to read in , process and visualise data, implement linear classification algorithms **CO2:** Compare classifiers with linear and non-linear decision boundaries, select relevant features for the model construction **CO3:** Apply data compression and best practices for model evaluation and hyper parameter tuning **CO4:** Select appropriate algorithms and ensemble **CO5:** Apply clustering algorithms on unlabelled data, construct a web application embedding a ML model						
Course Outline	**UNIT-I :** 1. Programs using NumPy and pandas 2. Visualising using graphs 3. Perceptron learning algorithm 4. Adaline						
	UNIT-II : **5.** Training a perceptron 6. Modeling class probabilities via logistic regression 7. Maximum margin classification with support vector machines(SVM) 8. Solving nonlinear problems using a kernel SVM 9. Decision tree						
	UNIT-III : 10. Unsupervised dimensionality reduction via principal component analysis 11. Supervised data compression via linear discriminant analysis 12. Using k-fold cross-validation to assess model performance 13. Debugging algorithms with learning and validation curves 14. Fine-tuning ML models via grid search 15. Implementing different performance evaluation metrics						

	UNIT-IV :
	16. Ensemble Learning
	17. Ordinary least squares linear regression model
	18. Evaluating the performance of linear regression models
	19. Regularised methods for regression
	20. Nonlinear relationships using random forests
	UNIT-V:
	21. Grouping objects by similarity using k-means
	22. Organising clusters as a hierarchical tree
	23. Locating regions of high density via DBSCAN
	24. Embedding a ML model into a Web Application
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	1. Mini project applying ML concepts in existing / real time data 2. Comparing the performance of different ML algorithms on a given dataset
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019
Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://machinelearningmastery.com/machine-learning-in-python-step-by-step/ 2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm 3. https://pythonprogramming.net/machine-learning-tutorial-python-introduction/

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	2	3	2
CO5	3	3	2	3	3	2
Weightage of course contributed to each PSO	15	13	12	14	13	11

Title of the Course	DATABASES FOR DATA SCIENCE						
Paper Number	CORE VII						
Category	Core	Year	II	Credits	4	Course Code	23PDS07
		Semester	III				

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	--	2	5

Pre-requisite	Fundamental computer knowledge including computer storage and hardware
Objectives of the Course	To provide fundamentals of database design, modeling systems, data storage, world of data warehousing and NoSQL
Learning Outcome	Students will be able to **CO1:** Understand and discuss the importance of relational data modeling and conceptual modelling **CO2:** Experiment with various database and compose effective queries **CO3**: Analyse the process of OLAP system construction **CO4:** Evaluate the use of NOSQL and its approach to the database **CO5:** Develop applications using Relational and NoSQL databases
Course Outline	**Unit 1** **1.1 Fundamental Concepts of Database Management** Applications of Database Technology - Key Definitions - File versus Database Approach to Data Management - Elements of a Database System - Advantages of Database Systems and Database Management - Architecture and Categorization of DBMSs **1.2 Conceptual Data Modeling using the ER Model and UML Class Diagram** Phases of Database Design - The Entity Relationship Model - UML Class Diagram
	Unit 2 **2.1 Types of Database Systems** Legacy Databases - Relational Databases: The Relational Model - Normalization **2.2 Relational Databases** Structured Query Language - SQL Data Definition Language - SQL Data Manipulation Language Lab: SQL DDL and DML

	Unit 3 **3.1 Data Warehousing and Business Intelligence** Operational versus Tactical/Strategic Decision-Making - Data Warehouse Definition - Data Warehouse Schemas - The Extraction, Transformation, and Loading (ETL) Process - Data Marts - Virtual Data Warehouses and Virtual Data Marts - Operational Data Store - Data Warehouses vs Data Lakes - Business Intelligence **3.2 Introduction of NO SQL** Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key Points Comparison of relational databases to new NoSQL stores, Mongo DB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, AggregateOriented Databases. sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer replication, Combining Sharding and Replication.
	Unit 4 **4.2 Key Value Data Stores** NoSQL Key/Value databases using MongoDB, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure. Lab: Key-value databases, Replica of existing database, Backup of existing database, Restore database from the backup Demonstration: Connecting python with mongodb and inserting, retrieving, updating and deleting.

	Unit 5
	5.1 Document Oriented Database
	Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage.
	5.2 Data Modeling with Graph
	Comparison of Relational and Graph Modeling, Property Graph Model Graph Analytics: Link analysis algorithm- Web as a graph, Page RankMarkov chain, page rank computation, Topic specific page rank Page Ranking Computation techniques iterative processing, Random walk distribution Querying Graphs
	Lab: Implement with column-family stores (cassandra), Graph databases (neo4j)
	Aggregate function, Push and addtoset expression, First and last expression.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case studies to understand the limitations of Relational DBMS and the need for NoSQL database Mini project - create a data store and process the data
Skills acquired from this course	Database designer, Data owner of different types of data, Data Scientist fluent in data, Business Professional
Recommended Text	Lemahieu, W., Broucke, S.vanden and Baesens, B. (2018) Principles of database management: The Practical Guide to storing, managing and analyzing big and small data. Cambridge, United Kingdom: Cambridge University Press. Sadalage, P. & Fowler,NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications,1st Edition,2022
Reference Books	1. SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis Renee M. P. Teate 2. SQL for Data Science: Data cleaning, wrangling and analytics with relational databases, Antonio Badia 3. Guy Harrison, Next Generation Database: NoSQL and big data, Apress
Website and e-Learning Source	**https://www.geeksforgeeks.org/introduction-to-nosql/**

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	2	3	3
CO2	2	3	2	2	3	3
CO3	2	3	2	2	3	3
CO4	3	3	2	2	3	3
CO5	3	3	2	2	3	3
Weightage of course contributed to each PSO	12	15	10	10	15	15

Title of the Course	CLOUD COMPUTING					
Paper Number	**CORE IX**					
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PDS09**
		Semester	IV				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**
	4		1		--	5
Pre-requisite	Basic concepts of Operating System. Familiar with using computers for different office duties					
Objectives of the Course	To provide an understanding of how cloud computing evolved, its acceptance world-wide and integral part of several organization					
Learning Outcome	Students will be able to **CO1:** Understand the models, principles, and benefits of Cloud Computing **CO2:** Understand virtualization foundations to cater the needs of elasticity, portability and resilience by cloud service providers. **CO3:** Identify the applications of Cloud Computing **CO4:** Analyse the security aspects of Cloud Computing **CO5:** Evaluate the importance of message passing and map reduce in Cloud Computing					
Course Outline	**Unit 1** **1.1 Introduction to Cloud Computing** Introduction – History - Fundamentals of Cloud computing – characteristics - Advantages and Disadvantages- Comparison of traditional and cloud computing paradigms- Evaluating the impact and economics - Business drivers- Future of cloud 44 **1.2 Services and Deployment model** Cloud deployment models - Cloud service models – Cloud infrastructure mechanisms - Cloud service management					

	Unit 2
	2.1 Cloud Computing Architecture
	Cloud computing architecture - Design principle - Life cycle (CCLC) -Reference architecture - Load balancing approach - Mobile cloud computing (MCC) - Case study of oracle cloud management
	2.2 Virtualization
	Understanding - Adoption – Techniques – Working of Virtualizaton - Kernel-based virtual machine (KVM) – VMware – VirtualBox – Citrix - Types of virtualization - Virtualisation in cloud
	Unit 3
	3.1 Service Oriented Architecture
	Objectives - SOA foundation - Web services and SOA - SOA communication - SOA components - SOA Infrastructure - Need of SOA - Business Process Management (BPM) – Services of BPM
	3.2 Cloud Computing Applications
	Introduction - Google App Engine - Google Apps - Google Cloud Data store - Dropbox Cloud - Apple iCloud - Microsoft Windows Azure Cloud - Amazon Web Services (AWS)
	Unit 4
	4.1 Cloud Security and Privacy
	Cloud Security - Cloud CIA security model - Cloud computing security
	Architecture - Service provider security issues - Security issues in Virtualization - Data security in cloud – Data privacy risks - Business continuity and disaster recovery - Threats in cloud – Security techniques for threats - Cloud service level agreements (SLA): Components – Types - Cloud vendors - Quality of Cloud Services - Techniques – Migration - Trust management
	Unit 5
	5.1 Cloud Computing Technologies
	Cloud Computing Technologies - High performance Computing - Message Passing Interface(MPI) - MapReduce programming model -Dryad and Dryad LINQ -Eucalyptus cloud platform: Components – OpenNebula: Layers – Features – OpenStack: components - Benefits – The Apache Hadoop ecosystem
	5.2 Adoption of Cloud Computing
	Factors affecting the adoption - Existing areas of application - Case studies - Certifications.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	More Case studies and Demonstration (To be discussed during the Lecture hour)

Skills acquired from this course	Platform expertise, selecting the right services, Managing an integrated environment and Securing the cloud environment
Recommended Text	Kant Hiran, Kamal, Ruchi Doshi, Temitayo Fagbola, Mehul Mahrishi, Cloud Computing: Master the Concepts, Architecture and Applications with Real-world examples and Case studies, BPB Publishers, 2019
Reference Books	Ben Piper and David Clinton, AWS Certified Solutions Architect Study Guide: Associate SAA-C01 Exam, Googel Book, 2019 Legorie Rajan Ps, Steven Porter, and Ted Hunter, Building Google Cloud Platform Solutions: Develop Scalable Applications from Scratch and Make Them Globally Available in Almost Any Language, Packt, 2019 Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, Tata McGraw Hill Education Private Limited, 2013
Website and e-Learning Source	**https://acloudguru.com** **https://www.cloudcomputing-news.net/** **https://cloudtweaks.com/**

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2
Weightage of course contributed to each PSO	15	15	10	15	15	10

Title of the Course	BIG DATA ANALYTICS					
Paper Number	**CORE X**					
Category	Core	**Year**	II	**Credits**	4	**Course Code**	**23PDS10**
		Semester	IV				
Instructional Hours per week	**Lecture**		**Tutorial**	**Lab Practice**		**Total**
	4		1	--		5
Pre-requisite	Basic understanding of programming and logical thinking					
Objectives of the Course	To introduce the concepts of big data analytics and developing a real time applications					
Learning Outcome	Students will be able to **CO 1:** Understand the basic concepts of big data analytics and technologies **CO 2:** Apply the concept of HDFS, Map reduce for storing and processing of Big data **CO 3:** Analyze and perform different operations on data using Pig, Hive, and Hbase **CO 4:** Evaluate the tools and methods for analyzing Big data analytics model **CO 5:** Develop real time big data analytics applications					
Course Outline	**UNIT-I : INTRODUCTION TO BIG DATA ANALYTICS** Classification of Digital Data, Structured and Unstructured Data - Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data - Other Characteristics of Data - Why Big Data - Traditional Business Intelligence versus Big Data - Data Warehouse and Hadoop Environment Big Data Analytics: Classification of Analytics – Challenges - Big Data Analytics important - Data Science - Data Scientist - Terminologies used in Big Data Environments. **Book 1 - Chapter 1,2,3**					
	UNIT-II : BIG DATA TECHNOLOGY LANDSCAPE NoSQL, Comparison of SQL and NoSQL, Hadoop -RDBMS Versus Hadoop - Distributed Computing Challenges – Hadoop Overview - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem **Book 1: Chapter 4, 5**					

	UNIT-III : HADOOP AND HDFS Introduction to Hadoop – RDBMS vs Hadoop- distributed computing challenges - A Brief History of Hadoop- The Hadoop Distributed Filesystem- Processing Data with Hadoop - Anatomy of a MapReduce Works - Anatomy of a MapReduce Job Run- Job Scheduling- Shuffle and Sort- Task Execution **Book 2 – Chapter 1, 3,6**
	UNIT-IV : HADOOP ECO SYSTEM Hive: Introduction – Architecture - Data Types - File Formats - Hive Query Language Statements – Partitions – Bucketing – Views - Sub- Query – Joins – Aggregations - Group by and Having - RCFile Implementation - Hive User Defined Function - Serialization and Deserialization. Pig: Introduction - Anatomy – Features – Philosophy - Use Case for Pig - Pig Latin Overview - Pig Primitive Data Types - Running Pig - Execution Modes of Pig - HDFS Commands - Relational Operators - Eval Function - Complex Data Types - Piggy Bank - User-Defined Functions - Parameter Substitution - Diagnostic Operator - Word Count Example using Pig - Pig at Yahoo! - Pig Versus Hive Hbase - HBasics, Concepts. **Book 1 - Chapter 9, 10** **Book 2 - Chapter 11, 12,13**
	UNIT-V: Case Studies Hadoop Usage at Last.fm - Hadoop and Hive at Facebook- Nutch Search Engine- Log Processing at Rackspace – Cascading - TeraByte Sort on Apache Hadoop 601 - Using Pig and Wukong to Explore Billion-edge Network Graphs - Recent Trends in Big Data Analytics **Book 2 - Chapter 16**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Developing application using big data analytic techniques
Recommended Text	1. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, First Edition, 2015, Wiley. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 2015.

Reference Books	1. Lublinsky, Boris, Kevin T. Smith, and Alexey Yakubovich. Professional hadoop solutions. John Wiley & Sons, 2013. 2. Big Data Analytics, RadhaShankarmani, M Vijayalakshmi, Second Edition, 2017, Wiley 3. Hadoop Essentials: A Quantitative Approach, Henry H. Liu, First Edition, 2012, PerfMath Publishers
Website and e-Learning Source	https://www.ibm.com/analytics/big-data-analytics https://www.simplilearn.com/what-is-big-data-analytics-article https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-is-big-data-analytics

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
Weightage of course contributed to each PO/PSO	15	15	10	15	15	15

Title of the Course	BIG DATA ANALYTICS LAB					
Paper Number	LAB III					
Category	Core	Year	II	Credits	4	Course Code	23PDSP03
		Semester	IV				
Instructional Hours per week	Lecture	Tutorial		Lab Practice	Total	
	-	-		5	5	
Pre-requisite	Basic understanding of programming and logical thinking					
Objectives of the Course	To introduce the concepts of big data analytics and developing a real time applications					
Learning Outcome	Students will be able to CO 1: Configure Hadoop and perform File Management CO 2: Apply Map Reduce program to real time issues. CO 3: Critically analyze huge data set using Hadoop distributed file systems and MapReduce CO 4: Experimenting different data processing tools like Pig, Hive. CO 5: Develop real time big data analytics applications					
Course Outline	**UNIT-I :** 1. Install Apache Hadoop 2. Perform setting up and Installing Hadoop in its three operating modes: • Standalone • Pseudo Distributed • Fully Distributed 3. To use Web Based Tools to Manage Hadoop Set-up 4. Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting Files					

UNIT-II :

4. Develop a MapReduce program to calculate the frequency of a given word in a given file.

5. Develop a MapReduce program to find the maximum temperature in each year.

6. Develop a MapReduce program to find the grades of student's.

7. Develop a MapReduce program to implement Matrix Multiplication.

8. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.

UNIT-III :

9. Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day. (National Climatic Data Centre (NCDC) Data set)

10. Develop a MapReduce program to find the number of products sold in each country by considering sales data containing fields like Tranction _Date Product Price Payment_Type Name City\State Country Account_Created Last_Login Latitude Longi

11. Data sets from different sources as Input

12. Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data. (https://www.kaggle.com/datasets/grouplens/movielens-20m-dataset)

12. Sorting the data using MapReduce

13. Count the number of missing and invalid values through joining two large given datasets.

UNIT-IV :

14. Install and Run Pig then write Pig Latin scripts to sort, group, join, project and filter the data.

15. Install and Run Hive then use Hive to Create, alter and drop databases, tables, views, functions and Indexes.

16. Develop a program to calculate the maximum recorded temperature by year wise for the weather dataset in Pig Latin

17. Develop a program to calculate the maximum recorded temperature by year wise for the weather dataset in Pig Latin

18. Write queries to sort and aggregate the data in a table using HiveQL

19. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.

20. Write a program to implement combining and partitioning in hadoop to implement a custom partitioner and Combiner

	UNIT-V:
	21. Analyze the sentiment for product reviews, this work proposes a MapReduce technique provided by Apache Hadoop
	22. Trend Analysis based on Access Pattern over Web Logs using Hadoop.
	23. Implementation of decision tree algorithms using MapReduce.
	24. Implementation of K-means Clustering using MapReduce.
	25. Generation of Frequent Itemset using MapReduce.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Mini Project – Application development
Skills acquired from this course	Developing application using big data analytic techniques
Recommended Text	1. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, First Edition, 2015, Wiley. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 2015.
Reference Books	1. Lublinsky, Boris, Kevin T. Smith, and Alexey Yakubovich. Professional hadoop solutions. John Wiley & Sons, 2013. 2. Big Data Analytics, RadhaShankarmani, M Vijayalakshmi, Second Edition, 2017, Wiley 3. Hadoop Essentials: A Quantitative Approach, Henry H. Liu, First Edition, 2012, PerfMath Publishers
Website and e-Learning Source	https://www.ibm.com/analytics/big-data-analytics https://www.simplilearn.com/what-is-big-data-analytics-article https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-is-big-data-analytics

Course Learning Outcome (for Mapping with POs and PSOs)

	PSOs						
	1	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	3	2	1	1
CO2	3	3	3	3	2	1	1
CO3	3	3	3	3	2	1	1
CO4	3	3	3	3	2	1	1
CO5	3	3	3	3	2	1	1
Weightage of course contributed to each PO/PSO	**15**	**15**	**15**	**15**	**10**	**5**	5

Title of the Course	PROJECT WITH VIVA VOCE					
Paper Number	CORE XI					
Category	Core	Year	II	Credits	3	Course Code	23PDSPR1
		Semester	IV				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
						5	5
Pre-requisite	Programming and Logical reasoning					

Elective I

Title of the Course	RESEARCH METHODOLOGY FOR COMPUTER SCIENCE						
Paper Number	**Paper I**						
Category	Elective-I	**Year**	I	**Credits**	3	**Course Code**	**23PDSE01**
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite	**Not Required**						
Objectives of the Course	To develop an understanding of the research methods relevant to effectively address a research problem						
Course Outline	**UNIT-I:** **1.1 Introduction to Research** Meaning, Objectives and Characteristics of research - Research Methods Vs. Methodology - Types of research- Research process - Criteria of good research **1.2 Research Project** Shaping a Research Project-Research Planning-Students and Advisors – Checklist						
	UNIT-II: **2.1 Literature Review** Reading and Reviewing - Hypotheses, Questions, and Evidence						
	UNIT-III: **3.1 Experiments for Computing** Experimentation-Statistical Principles **3.2 Writing a Paper** Organization-Good Style-Style Specifics-Punctuation-Mathematics-Algorithms- Graphs, Figures, and Tables -Other Professional Writing						
	UNIT-IV: **4.1 Presentation** Editing- Presentations-Slides-Posters-Ethics						
	UNIT-V: **5.1 Report writing** Report writing using LATEX for a research problem						
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Literature Review and Problem Identification Writing a research Paper (To be discussed during the Tutorial hour)						

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Research skill, Professional Communication and Transferrable Skill
Recommended Text	[1] Kothari C. R. Research Methodology Methods and Techniques. 2nd ed. New Delhi: New Age, 2004. (Unit 1.1) [2] Justin Zobel. Writing for Computer Science. 3rd ed. Springer-Verlag, 2014
Reference Books	[1] Ranjit Kumar. Research Methodology -a step-by-step guide for beginners. 3rd ed. SAGE Publications India Pvt Ltd, 2011. [2] Panneerselvam R. Research Methodology. 2nd ed. New Delhi: Prentice Hall, 2014.
Website and **e-Learning Source**	https://www2.le.ac.uk/offices/red/rd/research-methods-and-methodologies http://www.socscidiss.bham.ac.uk/methodologies.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Develop an understanding of research methods

CLO2: Formulate a research problem

CLO3: Collect and analyse data

CLO4: Effectively write a research paper

CLO5: Present the Paper more professionally.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Title of the Course	DATA STRUCTURES AND ALGORITHMS						
Paper Number	**Paper II**						
Category	Elective-I	**Year**	I	**Credits**	3	**Course Code**	**23PDSE02**
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite	**Not Required**						
Objectives of the Course	To develop an understanding of the research methods relevant to effectively address a research problem						
Course Outline	**UNIT-I:** **1.1 Basic Concepts** Basic steps in complete development of Algorithm - Analysis and complexity of Algorithm – Asymptotic notations - Problem Solving techniques and examples **1.2 ADT** List ADT, Stacks ADT, Queue ADT						
	UNIT-II: **2.1 Algorithm Design Model** Greedy Method - Divide and Conquer - Dynamic Programming – Backtracking – Branch and Bound **2.2 Trees** Preliminaries Binary Tree, Search Tree ADT, Binary Search Trees, AVL Trees, Tree Traversals, B-Trees						
	UNIT-III: **3.1 Hashing** General Idea, Hash Function, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing, Priority Queues, Model, Simple Implementations, Binary Heap, Applications						
	UNIT-IV: **4.1 Sorting** Sorting - Preliminaries, Insertion Sort, Shell Sort, Heap Sort, Merge Sort, Quick Sort, External Sorting						
	UNIT-V: **5.1 Graphs** Definitions, Topological Sort, Shortest Path Algorithm, Minimum Spanning Tree, Application of Depth First Search **5.2 Theory of NP-Completeness** Formal language framework, Complexity classes – P, NP - NP Reducibility and NP-Complete, NP-Hard						

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Aho, J. E. Hopcroft and J. D. Ullman. Design and Analysis of Computer Algorithms. 1st ed. Addison-Wesley, 2009. [2] Horowitz and Sahani. Fundamentals of Computer Algorithms. 2nd ed. Galgotia, 2008. [3] Weiss, M. A. Data Structure and Algorithm analysis in C. 2nd ed. Pearson Education Asia, 2002.
Reference Books	[1] Baase, S. and Allen Van Gelder. Computer Algorithms-Introduction to Design and Analysis.New Delhi: Pearson Education, 2008 [2] Goodrich, M.T. and R. Tamassia. Algorithm Design: Foundations, Analysis, and Internet Examples. New Delhi: Wiley, 2006.
Website and **e-Learning Source**	

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: To understand the design of algorithms and analysis techniques
CLO2: To enable the students to analyse the time and space complexity of algorithms
CLO3: To have a good understanding on different data structures
CLO4: To understand the kinds of problems that uses the data structures and the algorithms for solving them
CLO5: Identify appropriate data structures for real time applications

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Title of the Course	INTERNET OF THINGS						
Paper Number	Paper III						
Category	Elective I	Year	I	Credits	3	Course Code	23PDSE03
		Semester	I				
Instructional Hours per week	Lecture		Tutorial		Lab Practice	Total	
	4		1		--	5	
Pre-requisite	Knowledge in Computing and Networking						
Objectives of the Course	To understand the concepts, data, framework, standards, protocols, reliability, security and privacy involved in IOT						
Course Outline	**UNIT-I : IoT Ecosystem Concepts and Architectures** Introduction – IoT definition and evolution – IoT Architectures - OpenIoT 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 - 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: 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 : 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: Introduction - Concepts - IoT Security Overview – Security Frameworks for IoT – Privacy in IoT networks – IoT characteristics and reliability issues - Addressing reliability
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge on IOT Technology and its reliability, security and privacy, Developing a basic IOT system

Recommended Text	1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands - on Approach", 1st Edition 2015, University Press, ISBN: 978-81-7371- 954-7
	2. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.
	3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
Reference Books	1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978- 3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
	2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
	3. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
Website and e-Learning Source	https://thingsee.com/blog/quality-hardware-list-for-your-iot-projects https://tools.ietf.org/html/rfc7452. http://dret.net/lectures/iot-spring15/protocols http://iot.intersog.com/blog/overview-of-iot-development-standards-andframeworks.

Course Outcomes
On successful completion of the course, the student will be able:
CLO1: To describe the concepts of IoT
CLO2: To describe the essentials IOT data and framework
CLO3: To discuss IOT protocols
CLO4: To design a basic IOT system
CLO5: To examine the reliability, security and privacy of an IOT system

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	2	3
CLO2	3	3	1	2	2	3
CLO3	3	3	1	2	2	3
CLO4	3	3	3	2	2	3
CLO5	3	3	1	2	2	3

Elective II

Title of the Course	WEB PROGRAMMING					
Paper Number	Paper I					
Category	Elective II	Year	I	Credits	3	Course Code	23PDSE04
		Semester	I				

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	--	2	5

Pre-requisite	Basic programming knowledge
Objectives of the Course	To introduce students about web application and state management

Course Outline	**UNIT-I:** **1.1 Overview of .NET Framework:** CLR-CTS- Metadata and Assemblies-.NET Framework Class Library – BCL- Windows Forms – ASP.NET and ASP.NET AJAX-ADO.NET – Tools in the .NET Framework- New Features of .NET Framework: Portable Class Libraries. **1.2 Introducing Windows Application** Introduction – Creating WindowsForms- Customizing a Form **1.3 Collecting User Input in windows Forms and Events** Buttons-Text Boxes- Check Boxes- Radio Buttons –Combo Boxes –Date and TimePicker – Calendar-List Boxes –Checked List Box – List View – Tree View
	UNIT-II: **2.1 Presentation and Informational Controls in Windows Forms and Events** Labeling- Link Label- Status Bar- Picture Box-Image List-Progress Bar-Tool Tip –MDI and Menus Creation **2.2 Data Types in C#** Type Conversions – Boxing and Unboxing **2.3 Namespaces** Introduction – Adding a reference to the Namespace – Accessing a predefined Namespace through the using Directive **2.4 Introducing to ADO.net** Understanding ADO.NET- Creating Connection Strings –Creating a Connection to a Database- Creating a Command Object- Working with DataAdapters –Using DataReader work with Database.

UNIT-III:

3.1 ASP.NET
Life cycle- Specifying a Location for a Web Application -Single-File Page Model - Code-Behind Page Model- Adding controls to web form.

3.2 Web Server Controls
The Control Class - The WebControl Class - The Button Control - The TextBox Control -The Label Control - The HyperLink Control -The LinkButton Control -The PlaceHolder Control -The HiddenField Control - The CheckBox Control -The RadioButton Control -The ListBox Control -The DropDownList Control -The Image Control -The ImageButton Control - The Table Control - Menus - Validation Server
Controls - Master Page - Web.Config

UNIT-IV :

4.1 State Management
Understanding the session object Sessions and the Event Model, Configuring, In-Process Session State, Out-of-Process Session state Application Object, Query strings, Cookies, ViewState, Global.asax.

4.2 XML and .NET
Basics of XML, Create XML Document - Reading XML with XmlReader – Reading XML with XmlDocument - Working with XmlNode

4.3 Animations
Understanding WPF's Animation services – The Role of the Animation class types-The To, From and by properties – The Role of the Timeline Base Class – Authoring and Animation in C# Code – Controlling the pace of an animation – Reversing and Looping an Animation – The Role of StoryBoards

UNIT-V:

5.1 LINQ
Introducing LINQ Queries- Standard Query Operators- Introducing LINQ to Dataset, SQL and XML- The LinqDataSource Control.
Data Binding – Grid View, Details view, Forms view

5.2 ASP. NET AJAX
Understanding the need for AJAX, Building a simple ASP.NET page without AJAX, Building a simple ASP.NET page with AJAX

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Lab Exercises
Skills acquired from this course	Website creation
Recommended Text	[1] C# 2012 Programming Covers .NET 4.5 Black Book. Dreamtech press, Kogent Learning Solutions, 2013.(Unit 1.1,Unit 2.2,Unit 2.3,Unit 2.4, Unit 3,Unit 4, Unit 5) [2] Liberty, Jesse, and Dan Hurwitz. Programming. NET Windows Applications. " O'Reilly Media, Inc.", 2004. (Unit 1.2,1.3, 2.1) [3] Troelsen, Andrew, and Philip Japikse, C# 6.0 and the .NET 4.6 Framework. Apress, 2015. (Unit 4.3)
Reference Books	[1] Albahan Joseph, and Ben Albahari. C# 5.0 in a NutShell: The Definitive Reference. "Orielly Media Inc", 2012 [2] Anne Boehm . Joel. Murach's C# 2015. United States of America: Murach's,2016. [3] Delamater. Mary. Anne Boehm. ASP.NET 4.5 Web Programming with C# 2012. United States of America: Murach's, 2013. [4] John Sharp. Microsoft Visual C# Step by Step. United States of America: Pearson Edition,2018. [5] Price, Jason, and Mike Gunderlov. Mastering Visual C#.Net. John Wiley & Sons, 2006
Website and **e-Learning Source**	http://www.w3schools.com/aspnet/aspnet.asp http://csharp.net-tutorials.com/xml/introduction/ http://ajax.net-tutorials.com/basics/introduction/ http://www.c-sharpcorner.com/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Comprehend.NET Framework and Windows Application
CLO2	Know about presentation controls and namespaces
CLO3	Connect with backend using ADO.NET
CLO4	Get the knowledge about web application and state management
CLO5	Gain knowledge on connecting XML, LINQ and AJAX

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO						

Title of the Course	JAVA PROGRAMMING						
Paper Number	Paper II						
Category	Elective -II	Year	I	Credits	3	Course Code	23PDSE05
		Semester	I				

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	--	2	5

Pre-requisite	Basic programming knowledge
Objectives of the Course	To enable the students to understand and appreciate the need for Object Oriented Programming
Course Outline	**UNIT-I:** **1.1 Introduction to Java** Overview – Features - Fundamental OOPS concepts – JDK – JRE – JVM -Structure of a Java program - Data types – Variables – Arrays – Operators –Keywords - Naming Conventions - Control statements, Type conversion and Casting - Scanner - String - equals(), equalsIgnoreCase(), length()
	UNIT-II: **2.1 Classes and Objects** Class – Objects – Methods - Method Overloading - Constructors – Constructor Overloading - this keyword - usage of static with data and methods – Garbage Collection - Access Control **2.2 Inheritance** Concept – extends keyword - Single and Multilevel Inheritance – Composition – super keyword - Method Overriding - Abstract Classes - Dynamic Method Dispatch – Usage of final with data, methods and classes **2.3 Packages and Interfaces** Concepts - package and import keywords - Defining, Creating and Accessing a Package – Interfaces - Multiple Inheritance in Java, Extending and Initialising fields in Interfaces
	UNIT-III: **3.1 Exception Handling** Exception handling- Types of Exceptions- try, catch, throw, throws and finally keywords - User defined Exceptions **3.2 JDBC** Database Connectivity- Types of JDBC drivers- Executing statements-Prepared statements- Callable statements - Mapping SQL types to Java-ResultSetMetadata

	UNIT-IV :
	4.1 Multithreading Introduction - Life Cycle of a Thread, Thread class and Runnable Interface, Thread Priorities, Synchronisation **4.2 GUI Programming with JavaFX** JavaFX Basic Concepts – Packages - Stage and Scene Classes - Nodes and Scene Graphs – Layouts - The Application Class and the Lifecycle Methods - Launching a JavaFX Application - JavaFX Application Skeleton - Compiling and Running -Application Thread **4.3 JavaFX Controls** Label – Button – Image – RadioButton – CheckBox – ListView-ComboBox- TextField – ScrollPane
	UNIT-V: **5.1 Event** Event Handling – Input Event, Action Event and Window Event **5.2 Java Library** Java.util – List, ArrayList
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Lab Exercises
Skills acquired from this course	Object oriented Programming knowledge
Recommended Text	Schildt, Herbert. Java: The Complete Reference. McGraw-Hill Education Group, 2014
Reference Books	Eckel, Bruce. Thinking in Java. 4th ed. Pearson Education, 2006. Liang, Y. Daniel. Intro to Java Programming, Brief Version. Pearson Higher Ed, 2015. Holmes, J. Barry, Joyce, T. Daniel. Object-oriented Programming with Java. Jones & Bartlett Learning. 2001
Website and **e-Learning Source**	http://docs.oracle.com/javase/tutorial/java/index.html/ http://www.java2s.com/Tutorial/Java/CatalogJava.htm/ https://www.edureka.co/blog/object-oriented-programming/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the concepts of object-oriented programming
CLO2	Use Java programming language at a basic level and construct simple software applications
CLO3	Understand classes, objects and implementing inheritance
CLO4	Analyze and understand the functionality of Inheritance, Interface and develop simple applications
CLO5	To develop software applications and services using Java code

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Title of the Course	OPERATING SYSTEMS(Linux Based Commands for Practicals)						
Paper Number	Paper III						
Category	Elective II	Year	I	Credits	3	Course Code	23PDSE06
		Semester	I				

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	--	2	5

Pre-requisite	Basic programming knowledge
Objectives of the Course	To introduce students about web application and state management

Course Outline	**UNIT-I:** **1.1 Introduction to Operating System** Introduction to OS - Structure, Operations, Protection and Security, Kernel Data Structures, Computing Environments, Services, System Calls and its types, System Programs, OS Design and Implementation OS Debugging Operating, System Generation, System Boot **1.2 UNIX Operating System** History of UNIX, Shell, UNIX File System Structure **1.3 Basic UNIX Commands** Commands for files and directories cd, cp, mv, rm, mkdir, more, less, creating and viewing files, using cat, date, who, pwd - filter commands – head tail, cut, paste, grep – regular expression – sort
	UNIT-II: **2.1 Process Management** Process - Concept, Process Control Block, Process operations, Scheduling Algorithms - Short term and long term process scheduling policies – Scheduling Criteria - Multiple Processor Scheduling **2.2 CPU Scheduling** Scheduling Criteria – Scheduling Algorithms : FCFS, SJF, Priority and Round Robin Scheduling **2.3 Process Synchronization and Deadlocks** The Critical-section Problem – Petersons solution – Mutex locks - Semaphores – Monitors, Deadlock Prevention and Avoidance, Deadlock Detection and Deadlock Recovery **2.4 Process Utilities** sh process, Parents and children, Process status, System process, Mechanism of process creation, Internal and external commands, running jobs in background, KILL, NICE, Job control, at and batch, cron - Case Study on Processes in LINUX

UNIT-III:

3.1 File Organisation
File organisation and Access methods - Logical and Physical File structure – File Allocation methods, -Linked and Index Allocation - File Protection and Security - Directory structure - Single level, Two level, Tree structure - Free Space Management - Allocation Methods - Efficiency and Performance – Recovery – FAT32 and NTFS

3.2 File System
File Access Permission – chmod, chown, chgrp - File Comparisons - View Files – Listing files with attributes – Wildcards - Translating Characters - Links and its types - The File System – Partitions, File Systems, Kernel Accesses – Mounting – umask, ulimit - I/O redirection – Pipes - Case Study on LINUX File System

UNIT-IV :

4.1 Memory Management
Memory Management Techniques, Single Partition Allocation, Multiple Partition Allocation – Swapping - Paging and Segmentation - Segmented-Paged Memory Management Techniques - Logical and Physical Address space – Address Mapping - Demand paging - Virtual memory, protection and address mapping hardware, Page fault, Page replacement and Page removal algorithms

4.2 Device Management
Classification of device according to speed, Disk structure - Disk scheduling – FCFS scheduling, SSTF scheduling - Access method and storage capacity

4.3 Disk Utilities
Disk usage, disk free, dd, Backups- cpio, tar, System calls for file management, directory management - Case Study on Memory Management in LINUX

UNIT-V:

5.1 Security
The Security Enviroment – Operating System Security – Controlling Access to resources – Formal models of Secure systems - Basics of cryptography – Authentication – Exploiting Software – Insider Attacks – Malware - Defenses

5.2 Virtualization and the Cloud
History – Requirements for virtualization – Type 1 and Type 2 Hypervisors – Techniques for efficient virtualization – Memory virtualization – I/O Virtualization –Virtual Appliances – Virtual machines on multicore CPUs – Clouds: Clouds as service – Virtual machine migration – checkpointing - Case Study on Security in LINUX

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Linux based Commands
Skills acquired from this course	Knowledge and working of different operating system
Recommended Text	Silberschatz, Abraham, Peter Baer Galvin and Greg Gagne. Operating System Concepts. 10th ed. Addison Wesley. (Units 1 to 4 - Chapters 1-4, 6-13) Sumitabha Das. UNIX – Concepts & Applications. 3rd ed. New Delhi: TataMcGraw Hill, 2000. (Chapters 4-13,15,16) Tanenbaum S., Andrew, Herbert Bos. Modern Operating Systems. 4th ed. Pearson (Unit 5 - Chapter 7, 9, Case Studies – Chapter 10) Yukun Liu,Yong Yue,Liwei Guo UNIX Operating System The Development Tutorial via UNIX Kernel Services. Beijing: Higher Education Press (Chapters 1,2, 6-10)
Reference Books	Kanetkar Yashwant. UNIX Shell Programming. BPB. Rosen Kenneth, Douglas Host, Rachel Klee and Richard Rosinski.UNIX: The Complete Reference. 2nd ed. McGraw Hill/Osborne, 2007. Sobell M. G. A Practical Guide to Linux Commands, Editors, and Shell Programming. USA: Pearson Education
Website and e-Learning Source	www.tutorialspoint.com/unix www.unixtutorial.org/ www.guru99.com/unix-linux-tutorial.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Describe the basic components of an operating system and its services
CLO2	Define the concepts of processes, threads, asynchronous signals and competitive system resource allocation
CLO3	Outline standard scheduling algorithms for multi-tasking
CLO4	Describe secondary storage management
CLO5	Describe memory management and File management concepts

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Elective III

Title of the Course		INFORMATION SECURITY AND ETHICS					
Paper Number		Paper I					
Category	Elective III	Year	I	Credits	3	Course Code	23PDSE07
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice		Total
		4		1	--		5
Pre-requisite		Knowledge of Computer Basics					
Objectives of the Course		To introduce and familiarize the students to security issues in computing, core concepts and vocabulary of computer security					
Course Outline		**UNIT-I :** **1.1 Security Problem in Computing** Meaning of "Secure" – Attacks - Meaning of Computer and information Security - Computer Criminals - Methods of Defense **1.2 Cryptography** Terminology and Background - Principles of Cryptography - Cryptography tools - Substitution Ciphers - Transpositions (Permutations) – Making "Good" Encryption Algorithms - The Data Encryption Standard (DES) – The AES Encryption Algorithm - Public Key Encryption - The Uses of Encryption - Digital Signatures and Certificates - Hybrid Cryptography Systems - Steganography - Protocols for secure communication					
		UNIT-II : **2.1 Program Security** Secure Programs - Nonmalicious Program Errors - Viruses and Other Malicious Code - Targeted Malicious Code - Controls against Program Threats **2.2 Security Issues in Social Networking** Acceptable Use Policies - Reasons for social media being hazardous to the corporate network - Balancing Security and Social Networking in business - Precautions that can be taken to secure the private information					
		UNIT-III : **3.1 Database and Data Mining Security** Introduction to Databases - Security Requirements - Reliability and Integrity – Sensitive Data - Inference - Multilevel Databases - Proposals for Multilevel Security – Data Mining **3.2 Security in Networks** Network Concepts - Threats in Networks - Network Security Controls - Firewalls – Intrusion Detection Systems - Secure E-Mail					

	UNIT-IV : **4.1 Administering Security** Security Planning - Risk Analysis - Organisational Security Policies - Physical Security **4.2 The Economics of Cyber security** Making a Business Case - Quantifying Security - Modeling Cyber security
	UNIT-V: **5.1 Privacy in Computing** Privacy Concepts - Privacy Principles and Policies - Authentication and Privacy – Data Mining - Privacy on The Web - E-Mail Security - Impacts on Emerging Technologies **5.2 Legal and Ethical Issues in Computer Security** Protecting Programs and Data - Information and the Law - Rights of Employees and Employers - Redress for Software Failures - Computer Crime - Ethical Issues in Computer Security - Case Studies of Ethics
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration on computer security Case Studies (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Pfleeger ,Charles P and Shari Lawrence Pfleeger. Security in Computing, Released January 2015, Pearson, ISBN: 9780134085074
Reference Books	Bahadur ,Gary. Securing the Clicks Network Security in the Age of Social Media. 1st ed. McGraw-Hill, 2012. Daswani, Neil, Christoph Kern and Anita Kesavan. Foundations of Security: What Every Programming Needs to Know. Apress, 2007
Website and **e-Learning Source**	http://www.trendmicro.fr/media/wp/securityguide-social-networks-whitepaper-en.pdf http://paper.ijcsns.org/07_book/201306/20130619.pdf

Course Learning Outcome (for Mapping with POs and PSOs) Students will be able to

CO's	Course Outcomes
CLO1	Understand all aspects of computer security, including users, software, devices, operating systems, networks, law, and ethics
CLO2	Apply cryptography an essential tool that is critical to computer security
CLO3	Analyse the different aspects of computer security and privacy

CLO4	Evaluate the aspects of computer security
CLO5	Develop a system that uses user authentication, prevents malicious code execution, encrypts the data, protects privacy, implements firewall, detects intrusion, and more.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to eachPSO	15	15	15	10	5	5

Title of the Course	DISTRIBUTED SYSTEMS					
Paper Number	Paper II					
Category	Elective III	Year	I	Credits	3	Course Code	23PDSE08
		Semester	II			
Instructional Hours per week	Lecture		Tutorial		Lab Practice	Total
	4		1		--	5
Pre-requisite	Fundamentals of Operating Systems concepts and Networking					
Objectives of the Course	To learn the principles, architectures, Processes, Communication, Co-ordination, consistency and Replication in Distributed Systems					
Course Outline	**UNIT-I: Introduction -** Introduction to Distributed Systems - Design Goals - Types of Distributed Systems **Chapter 1**					
	UNIT-II: Architectures - Architectural Styles - Middleware Organization - System Architecture - Example Architectures **Chapter 2**					
	UNIT-III: Processes: Threads - Virtualization - Clients - Servers - Code Migration **Chapter 3**					
	UNIT-IV: Communications: Foundations - Remote Procedure Call - Basic RPC operation, Parameter Passing, RPC based Application Support - Message Oriented Communication - Simple transient Messaging with Sockets, Advanced Transient Messaging, Message Oriented Persistent Communication — Multicast Communication **Chapter 4** **Naming:** Names, Identifiers and Addresses - Flat naming - Structured naming - Attribute-based naming **Chapter 5**					

	UNIT-V: Co-ordination: Clock Synchronisation - Logical Clocks - Mutual Exclusion - Election Algorithms - Distributed Event Management **Chapter 6 - 6.1,6.2,6.3,6.4,6.6** **Consistency and Replication:** Introduction - Data-centric Consistency Models - Client- Centric Consistency Models - Replica Management **Chapter 7-7.1 to 7.4** **Fault Tolerance: Introduction** **Chapter 8-8.1**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Applications of Distributed Systems (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge of Distributed Systems Concepts and its Architecture
Recommended Text	1. Andrew S. Tannenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Third Edition, Pearson, 2017.
Reference Books	1. George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition, Addison Wesley, 2011. 2. James E. Smith, and Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", First Edition, Morgan Kaufmann, 2005.
Website and e-Learning Source	1. https://www.tutorialspoint.com/Distributed-Systems 2. https://link.springer.com/article/10.1007/s00607-016-0508-7

Course Outcomes

On successful completion of the course, the student will be able:

CLO1: To explain the significance of Distributed Systems

CLO2: To explain the architecture of Distributed Systems

CLO3: To relate the different types of Processes's role in Distributed Systems

CLO4: To describe the rules the communicating processes must adhere to

CLO5: To examine the issues in Distributed Systems

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	2	1	1
CLO2	3	3	2	2	1	1
CLO3	3	3	2	2	1	1
CLO4	3	3	2	2	1	1
CLO5	3	3	2	2	2	3

Title of the Course	SOFTWARE ENGINEERING FOR DATA SCIENCE						
Paper Number	**Paper III**						
Category	Elective III	**Year**	I	**Credits**	3	**Course Code**	23PDSE09
		Semester	II				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**		**Total**
	4		1		--		5
Pre-requisite	Basic Knowledge in Programming						
Objectives of the Course	To understand the software engineering principles and ensure software quality						
Course Outline	**UNIT-I :** **Software and Software Engineering:** The nature of software - Software Engineering - The Software Process - Software Engineering Practice - Software Myths **Chapter 1** **Process Models :** A Generic Process Model - Process Assessment and Improvement - Prescriptive Process Models - Product and Process **Chapter 2** **Agile Development :** Introduction - Agility and Cost of Change - Agile Process - Scrum - Other Agile Frameworks **Chapter 3**						
	UNIT-II : Recommended Process Model : Requirements Definition - Preliminary Architectural Design - Resource Estimation - First Prototype Construction - Prototype Evaluation - Prototype Evolution - Prototype Release - Maintain Release Software **Chapter 4** **Human Aspects of Software Engineering:** Characteristics of a Software Engineer - The Psychology of Software Engineer - The Software Team - Team Structures - The impact of Social Media - Global Teams **Chapter 5** **Principles that guide practice** : Core Principles - Principles that guide each Framework Activity - Communication Principles - Planning Principles - Modeling Principles - Construction Principles - Deployment Principles **Chapter 6**						

	UNIT-III :
	Understanding Requirements: Requirements Engineering - Establishing the groundwork - Requirements Gathering - Developing Use Cases -Building the Analysis Model - Negotiating Requirements - Requirements Monitoring - Validating Requirements
	Chapter 7
	Requirements Modeling - A Recommended Approach: Requirements Analysis - Scenario-Based Modeling - Class-Based Modeling - Functional Modeling - Behavioural Modeling
	Chapter 8
	UNIT-IV : Design Concepts: Design within the context of Software Engineering - The Design Process - Design Concepts - The Design Model
	Chapter 9
	Quality and Security : Introduction - Software Quality - The Software Quality Dilemma - Achieving Software Quality
	Chapter 15
	Software Quality Assurance: Background Issues - Elements of Software Quality Assurance - SQA Process and Product Characteristics - SQA Tasks, Goals and Metrics - Formal Approaches - Statistical SQA - Software Reliability - ISO 9000 Quality standards - SQA Plan
	Chapter 17
	UNIT-V: Software Testing -Component Level: A Strategic Approach to Software Testing - Planning and RecordKeeping - Test-Case Design - White-box Testing - Black-Box Testing - Object-oriented Testing
	Chapter 19
	Software Testing - Integration Level: Software Testing Fundamentals - Integration Testing - Artificial Intelligence and Regression Testing - Integration Testing in the OO context - Validation Testing - Testing Patterns
	Chapter 20
	Data Science for Software Engineers
	Appendix 2

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies (To be discussed during the Tutorial hour)
Skills acquired from this course	Software Engineering approaches for tradition software and Data Science
Recommended Text	1. Pressman, Roger S., and Bruce R. Maxim. Software Engineering: A Practitioner's Approach, Ninth Edition, 2020.
Reference Books	1. Martin, Robert C. Agile software development: principles, patterns, and practices. Prentice Hall, 2002. 2. Schach, Stephen R. Object-oriented software engineering. McGraw-Hill, 2008. 3. Sommerville, Ian. "Software engineering 9th Edition." ISBN-10 137035152 (2011).
Website and e-Learning Source	https://www.d.umn.edu/~gshute/softeng/principles.html

Course Outcomes
On successful completion of the course, the student will be able:
CLO1: To describe the Software Engineering Principles
CLO2: To apply Software Life Cycle Models for Software Development
CLO3: To use Requirements Engineering skills and gather Requirements
CLO4: To develop a quality Software
CLO5: To apply appropriate testing methodologies

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	2	1
CLO2	3	3	1	2	2	3
CLO3	3	3	1	2	2	2
CLO4	3	3	3	2	2	2
CLO5	3	3	1	2	2	2

Elective IV

Title of the Course	APPLIED PROBABILITY						
Paper Number	Paper I						
Category	Elective-IV	Year	I	Credits	3	Course Code	23PDSE10
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice		Total
		4		1	--		5
Pre-requisite		Basic Probability					
Objectives of the Course		To develop knowledge and understand fundamental concepts and applications of probability					
Course Outline		**UNIT-I:** **1.1 Basic Notions of Probability Theory** Introduction-Probability and Expectation-Sample Spaces and Events-Random Experiments, Sample Spaces, Events, Counting Techniques-Interpretations and Axioms of Probability-Addition Rules-Conditional Probability-Multiplication and Total Probability Rules-Independence-Bayes' Theorem-Random Variables-Distributions, Densities, and Moments-Convolution-Random Vectors-Multivariate Normal Random Vectors **1.2 Calculation of Expectations** Introduction-Indicator Random Variables and Symmetry-Conditioning-Moment Transforms-Tail Probability Methods-Moments of Reciprocals and Ratios-Reduction of Degree-Spherical Surface Measure					
		UNIT-II: **Convexity and Combinatorics** Introduction-Convex Functions-Minimization of Convex Functions-The MM Algorithm-Moment Inequalities-Combinatorics-Introduction-Bijections-Inclusion-Exclusion -Applications to Order Statistics-Catalan Numbers-Pigeonhole Principle-Combinatorial Optimization-Introduction-Quick Sort-Data Compression and Huffman Coding-Graph Coloring					

UNIT-III:

3.1 Discrete Random Variables

Probability Distributions and Probability Mass Functions-Cumulative Distribution Functions-Mean and Variance of a Discrete Random Variable-Discrete Uniform Distribution-Binomial Distribution-Geometric and Negative Binomial Distributions-Hypergeometric Distribution-Poisson Distribution

3.2 Continuous Random Variables

Probability Distributions and Probability Density Functions-Cumulative Distribution Functions-Mean and Variance of a Continuous Random Variable-Continuous Uniform Distribution-Normal Distribution - Normal Approximation to the Binomial and Poisson Distributions-Exponential Distribution-Erlang and Gamma Distributions-Weibull Distribution-Lognormal Distribution-Beta Distribution

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UNIT-IV:

4.1 Two or More Random Variables

Joint Probability Distributions-Marginal Probability Distributions-Conditional Probability Distributions-Independence-More Than Two Random Variables-
Covariance and Correlation-Common Joint Distributions-Multinomial Distribution-Bivariate Normal Distribution-Linear Functions of Random Variables-General Functions of Random Variables

4.2 Sampling Distributions and Point Estimation of Parameters

Point Estimation-Sampling Distributions and the Central Limit Theorem-General Concepts of Point Estimation-Unbiased Estimators-Variance of a Point Estimator -Standard Error: Reporting a Point Estimate-Mean Squared Error of an Estimator-Methods of Point Estimation-Method of Moments-Method of Maximum Likelihood-Bayesian Estimation of Parameters

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UNIT-V:

5.1 Discrete-Time Markov Chains

Introduction-Definitions and Elementary Theory-Examples-Coupling-Convergence Rates for Reversible Chains-Hitting Probabilities and Hitting Times-Markov Chain Monte Carlo-simulated annealing

5.2 Continuous-Time Markov Chains

Introduction-Finite-Time Transition Probabilities-Derivation of the Backward Equations-Equilibrium Distributions and Reversibility-Examples-Calculation of Matrix Exponentials-Kendall's Birth-Death-Immigration Process

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Lange, Kenneth. Applied probability. Vol. 224. New York: Springer, 2003. [2] Douglas C. Montgomery, George C. Runger,Applied Statistics and Probability for Engineers, Fifth Edition, John Wiley & Sons, Inc.
Reference Books	[1] Mario Lefebvre, Applied Probability and Statistics, Springer Newyork, 2006 [2] Michael Mitzenmacher Eli Upfal, Probability and Computing Randomized Algorithms and Probabilistic Analysis, Cambridge University press, 2005
Website and **e-Learning Source**	https://open.umn.edu/opentextbooks/textbooks/256 https://www.intechopen.com/books/12021

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Define the principal concepts about probability.
CLO2: Understand combinatorics and convexity
CLO3: Understand the nature and properties of density functions and hence determine the moments and moment generating functions of any random variable
CLO4: Obtain the value of the point estimators using the method of moments and method of maximum likelihood
CLO5: Define and formulate discrete-time and continuous-time Markov chains

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	15	15	15	10	5	5

Title of the Course	**OPTIMIZATION TECHNIQUES**						
Paper Number	**Paper II**						
Category	Elective-IV	**Year**	I	**Credits**	3	**Course Code**	**23PDSE11**
		Semester	II				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite	Fundamentals of optimization and Linear algebra						
Objectives of the Course	To study of model formulation and apply the mathematical results and numerical techniques of optimization theory to real world problems						
Course Outline	**UNIT-I:** **1.1 Modelling with Linear programming** Two variable LP model – Graphical LP solution – Applications. **1.2 Simplex method and sensitivity analysis** Simplex method- Artificial starting solution - Special cases in simplex method- Graphical sensitivity analysis.						
	UNIT-II: **2.1 Duality and post-optimal Analysis** Definition of Dual problem - Primal-Dual Relationships-Additional Simplex algorithms- Post optimal analysis **2.2 Advanced Linear Programming** Simplex method fundamentals-Revised Simplex Method, Bounded-Variable Algorithm, Duality, Parametric programming						
	UNIT-III: **3.1 Goal Programming** Goal programming formulation - Goal Programming algorithms **3.2 Integer Programming** Formulation and Applications-Cutting Plane Algorithm-Branch and Bound Method						
	UNIT-IV: **4.1 Heuristic Programming** Greedy Heuristics- Meta heuristic - Tabu Search algorithm - Constraint programming **4.2 Deterministic dynamic programming** Recursive nature of Dynamic programming computations - Forward and backward recursion- Selected DP applications - Knapsack/Fly-away kit/cargo-loading model- Investment models-Inventory models						

	UNIT-V:
	5.1 Queuing Systems
	Pure birth and Pure death models- Generalized Poisson queuing model, single server models.
	5.2 Classical optimization theory
	Unconstrained problems - Constrained problems
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Implement Lab Exercises in python and solve problems related to the above topics (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Hamdy A.Taha, Operations Research- An Introduction, 10th Edition, Pearson Education – 2017.
Reference Books	[1] L.R.Foulds, Optimization Techniques , Springer ,Utm , 1981 [2] Garrido José M. Introduction to Computational Models with Python. CRC Press, 2016.
Website and **e-Learning Source**	https://www.pre-scient.com/knowledge-center/optimization-problems/optimization-problems.html https://www.shsu.edu/~eco_dgf/web_chapter_a.pdf

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Explain the fundamental knowledge of Linear Programming
CLO2: Use classical optimization techniques and numerical methods of optimization.
CLO3: Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems
CLO4: Describe the basics of different Heuristic algorithms and solve dynamic programming problems.
CLO5: Understand Queuing systems and understand constrained and unconstrained problems

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Title of the Course	DISCRETE MATHEMATICS					
Paper Number	Paper III					
Category	Elective-IV	Year	I	Credits	3	Course Code	23PDSE12
		Semester	II			
Instructional Hours per week	Lecture		Tutorial		Lab Practice	Total
	4		1		--	5
Pre-requisite	Basic mathematics					
Objectives of the Course	To develop knowledge and understand concepts of mathematical induction, logic, functions and relations					
Course Outline	**UNIT-I:** **1.1 Sets, Sequences and Functions** Sets-Some Special Sets-Set Operations-Functions-Sequences-Properties of Functions-Propositions-Conditional Propositions and Logical Equivalence-Arguments and Rules of Inference-Quantifiers-Nested Quantifiers **1.2 Elementary Logic** Informal Introduction-Propositional Calculus-Getting Started with Proofs-Methods of Proof-Logic in Proofs-Analysis of Arguments					
	UNIT-II: **2.1 Relations** Relations-Digraphs and Graphs-Matrices-Equivalence Relations and Partitions-The Division Algorithm and Integers Mod p **2.2 Induction and Recursion** Loop Invariants-Mathematical Induction-Big-Oh Notation-Recursive Definitions-Recurrence Relations-More Induction-The Euclidean Algorithm					
	UNIT-III: **3.1 Counting** Basic Counting Techniques-Elementary Probability-Inclusion-Exclusion and Binomial Methods-Counting and Partitions-Permutations and Combinations, Binomial Coefficients and Identities, Equivalence Relations, Generalized Permutations and Combinations, Generating Functions, Inclusion-Exclusion, Applications of Inclusion-Exclusion-Pigeon-Hole Principle **3.2 Algorithms** Introduction-Examples of Algorithms-Analysis of Algorithms-Recursive Algorithms					

	UNIT-IV: **4.1 Graphs** Graphs-Paths and Cycles-Edge Traversal Problems-Hamiltonian Cycles and the Traveling Salesperson Problem-A Shortest-Path Algorithm-Representations of Graphs-Isomorphisms of Graphs-Planar Graphs **4.2 Trees** Trees-Terminology and Characterizations of Trees-Rooted Trees-Vertex Traversal Problems-Spanning Trees-Minimal Spanning Trees-Binary Trees- Tree Traversals-Decision Trees and the Minimum Time for Sorting - Isomorphism of Trees
	UNIT-V: **Recursion and Digraphs** General Recursion-Depth-First Search Algorithms-Polish Notation-Weighted Trees-Digraphs-Digraphs Revisited-Weighted Digraphs and Scheduling Networks-Digraph Algorithms
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Kenneth A. Ross and Charles R. B. Wright, Discrete Mathematics, Pearson Education,Fifth Edition [2] Richard Johnsonbaugh, Discrete Mathematics, Pearson Education,Eighth Edition, 2018
Reference Books	[1] Discrete Mathematics and its Applications (6th edition), Kenneth H. Rosen, Tata McGraw Hill, Bombay, India [2] Discrete Mathematics with Applications Susanna S. Epp, Brooks/Cole 2011 [3] Discrete Mathematics an Introduction to Proofs and Combinatorics, Kevin Ferland, Houghton Mifflin Company, 2009
Website and **e-Learning Source**	https://www.tutorialspoint.com/discrete_mathematics/discrete_mathematics_introduction.htm https://www.cs.odu.edu/~toida/nerzic/content/intro2discrete/intro2discrete.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: To introduce Mathematical Logic to understand the equivalence of statements
CLO2: To acquaint the students with Inference Theory and predicate calculus to understand partial order and partition.

CLO3: To introduce fundamental principles of Combinatorial Counting techniques
CLO4: To explain generating functions and their utility in solving recurrence relations
CLO5: To introduce graph models and tree structures with basics and significance of traversability.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

Elective V

Title of the Course	NATURAL LANGUAGE PROGRAMMING						
Paper Number	Paper I						
Category	ELECTIVE V	Year	II	Credits	3	Course Code	23PDSE13
		Semester	III				

Instructional Hours per week	Lecture		Tutorial	Lab Practice		Total	
	4		1	--		5	

Pre-requisite	Basic understanding of programming and machine learning
Objectives of the Course	To explore the concepts and fundamentals of Natural Language Programming

Course Outline	**UNIT-I: INTRODUCTION TO NLP** Knowledge in Speech and Language Processing – Ambiguity - Models and Algorithms- Language, Thought, and Understanding - The State of the Art - History - Applications – Basic NLP **Book1 : Chapter 1, Book 2: Chapter 1**
	UNIT-II: WORD ANALYSIS Regular Expressions - Words & Transducers- Survey of English Morphology- Finite-State Morphological Parsing - Word and Sentence Tokenization- N-grams- Counting Words in Corpora- Simple (Unsmoothed) N-grams- Training and Test Sets- Part-of-Speech Tagging- English Word Classes- Tagsets for English- Part-of-Speech Tagging- Rule-Based Part-of-Speech Tagging- Evaluation and Error Analysis **Book1 : Chapter 2, 3,4,5**

	UNIT-III: SYNTACTIC ANALYSIS Formal Grammars of English- Constituency- Context-Free Grammars- Grammar Rules for English - Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars - Parsing with Context-Free Grammars - Parsing as Search- Dynamic Programming Parsing Methods- Statistical Parsing- Probabilistic Context-Free Grammars- Probabilistic CKY Parsing of PCFGs- Learning PCFG Rule Probabilities **Book1 : Chapter 12, 13, 14**
	UNIT-IV: SEMANTICS AND PRAGMATICS Computational Desiderata for Representations- First-Order Logic, Computational Semantics –Syntax Driven Semantic analysis, Semantic attachments Semantic Attachments for a Fragment of English, Lexical Semantics- Word Senses, Relations between Senses, WordNet: A Database of Lexical Relations- Event Participants: Semantic Roles and Selectional Restriction **Book1: Chapter 17, 18,19**
	UNIT-V: APPLICATIONS Applications - Information Extraction, Question Answering and Summarization, Dialogue and Conversational Agents **Book1 : Chapter 22, 23,24**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply NLP programming to real time problems.

Recommended Text	1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014. 2. Patel, Ankur A., and Ajay Uppili Arasanipalai. Applied Natural Language Processing in the Enterprise. " O'Reilly Media, Inc.", 2021.
Reference Books	1. Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015. 2. Richard M Reese, —Natural Language Processing with Java‖, O_Reilly Media, 2015. 3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010. 4. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval‖, Oxford University Press, 2008.
Website and **e-Learning Source**	https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-natural-language-processing-nlp https://towardsdatascience.com/your-guide-to-natural-language-processing-nlp-48ea2511f6e1 https://www.oracle.com/in/artificial-intelligence/what-is-natural-language-processing/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the fundamentals of Natural Language Processing.
CLO2	Apply the NLP techniques for word and syntactic analysis.
CLO3	Analyze the natural language text.
CLO4	Evaluate the tools and methods for understanding semantics of sentences and pragmatics.
CLO5	Develop an innovative application using NLP components

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	15	15	15	10	5	5

Title of the Course	REINFORCEMENT LEARNING						
Paper Number	Paper II						
Category	ELECTIVE V	Year	II	Credits	3	Course Code	23PDSE14
		Semester	III				

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	4	1	--	5

Pre-requisite	Basic understanding of machine learning types
Objectives of the Course	To introduce the concepts and fundamentals of reinforcement learning and methods
Course Outline	**UNIT-I: INTRODUCTION AND BASICS OF REINFORCEMENT LEARNING** The Reinforcement Learning Problem - Reinforcement Learning-Examples- Elements of Reinforcement Learning- Limitations and Scope -An extended example – History of Reinforcement Learning - Applications - Ethics in RL- Applying RL for real-world problems- Meta-learning- Multi-Agent Reinforcement Learning **Book 1- Chapter 1**
	UNIT-II: TABULAR METHODS Finite Markov Decision Processes **-** Dynamic Programming - Monte Carlo Methods **Book 1- Chapter 3,4,5**
	UNIT-III: Q-NETWORKS AND LEARNING Temporal difference learning – n-step Bootstrapping- Planning and learning with tabular methods, Deep Q-networks- DQN, DDQN, Dueling DQN, Prioritised Experience Replay **Book 1- Chapter 6,7,8**

	UNIT-IV: APPROXIMATE SOLUTION METHODS On-policy prediction with approximation – on-policy control with approximation – policy gradient methods **Book 1- Chapter 9,10,13**
	UNIT-V: PSYCHOLOGY AND NEUROSCIENCE Prediction and control - Classical conditioning – neuroscience – basics-reward and prediction -case studies **Book 1- Chapter 14,15,16**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply Reinforcement Learning core principals and tasks for real time problems.
Recommended Text	1. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.
Reference Books	1. Szepesvári, Csaba. "Algorithms for reinforcement learning." Synthesis lectures on artificial intelligence and machine learning 4.1 (2010): 1-103. 2. Winder, Phil. Reinforcement learning. O'Reilly Media, 2020. 3. Bilgin, Enes. Mastering Reinforcement Learning with Python: Build next-generation, self-learning models using reinforcement learning techniques and best practices. Packt Publishing Ltd, 2020.
Website and **e-Learning Source**	https://developer.ibm.com/learningpaths/get-started-automated-ai-for-decision-making-api/what-is-automated-ai-for-decision-making/ https://towardsdatascience.com/reinforcement-learning-101-e24b50e1d292 https://www.analyticsvidhya.com/blog/2021/02/introduction-to-reinforcement-learning-for-beginners/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the fundamentals of Reinforcement Learning tasks and the core principals including policies, value and functions.
CLO2	Apply the tabular and approximation methods to solve classical control problems.
CLO3	Analyse policy gradient methods to solve more complex cases.
CLO4	Evaluate the tools and methods used for prediction and control.
CLO5	Investigate the current advanced techniques and applications in Reinforcement Learning.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	15	15	15	10	5	5

Title of the Course		SOCIAL NETWORK ANALYSIS						
Paper Number		Paper III						
Category	Elective V	Year	II	Credits	3	Course Code		23PDSE15
		Semester	III					

Instructional Hours per week	Lecture		Tutorial	Lab Practice		Total	
	4		1	--		5	

Pre-requisite	Basic understanding of social networks
Objectives of the Course	To introduce the concepts and fundamentals of social network components and analysis
Course Outline	**UNIT-I: INTRODUCTION TO SEMANTIC WEB AND SOCIAL NETWORKS** Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis- Brief history of Social network analysis **Book 1- Chapter 1,2,3 Book 2: Chapter 1**
	UNIT-II: MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION Knowledge Representation on the semantic web- Ontology and their role in the Semantic Web - Ontology languages for the Semantic Web- Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations **Book 1: Chapter 4,5,6**

	UNIT-III: DATA COLLECTION
	Boundary specification – Data collection process- Information bias and issue of reliability – Archival data – Understanding SNA data – Managing SNA data **Book2 : Chapter 2**
	UNIT-IV : METHODS IN SOCIAL NETWORK ANALYSIS Descriptive methods – Graph – Density- Centrality – cliques – MDS-structural equivalence – Two mode networks – Inferential methods – QAP- ERGM **Book 2- Chapter 3, 4**
	UNIT-V: CASE STUDIES Case studies – Evaluation of web-based social network extraction – semantic – based social network analysis in the sciences – emergent semantics **Book 1: Chapter 7,8,9**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply social network in real time applications
Recommended Text	1. Peter Mika, "Social Networks and the Semantic Web", Springer 2007. 2. Yang, Song, Franziska B. Keller, and Lu Zheng. Social network analysis: Methods and examples. Sage Publications, 2016.

Reference Books	1. Guandong Xu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications‖, First Edition, Springer, 2011. 2. Dion Goh and Schubert Foo, ―Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively‖, IGI Global Snippet, 2008.
Website and **e-Learning Source**	https://bookdown.org/chen/snaEd/ch4.html https://www.sciencedirect.com/topics/social-sciences/social-network-analysis https://www.publichealth.columbia.edu/research/population-health-methods/social-network-analysis https://www.ibm.com/docs/en/spss-modeler/18.0.0?topic=analysis-about-social-network

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the fundamentals of social web and elements of social network analysis.
CLO2	Apply and visualize the knowledge representation in social network.
CLO3	Analyse the various methods in social network analysis.
CLO4	Evaluate the tools and methods for analysing the social network data.
CLO5	Investigate the recent potential applications and development of social network with real time case studies.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	**15**	**15**	**15**	**10**	**5**	**5**

ELECTIVE VI

Title of the Course	ARTIFICIAL INTELLIGENCE AND DATA SCIENCE					
Paper Number	**Paper I**					
Category	Elective VI	**Year**	II	**Credits**	3	**Course Code**	**23PDSE16**
		Semester	IV			
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**		**Total**
		4		1	--		5
Pre-requisite	knowledge of Computer Science and Mathematics					
Objectives of the Course	To explore the approaches and principles of Artificial Intelligence (AI) algorithms, and apply them to Data Science					
Course Outline	**UNIT-I :** **1.1 Artificial Intelligence** The AI Problems - The Underlying Assumptions – What is an AI Technique – The Level of the Model – Criteria for Success. **1.2 Problems, Problem Spaces & Search** Defining the problem as a State Space Search – Production systems – Problem Characteristics - Production Systems Characteristics – Issues in the Design of Search Programs. **1.3 Heuristic Search Techniques** Generate and Test – Hill Climbing – Best First Search – Problem Reduction - Constraint Satisfaction – Means ends Analysis.					

UNIT-II :

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

UNIT-III :

3.1 Learning
What is Learning - Rote Learning – Learning by Taking Advice – Learning by Problem Solving – Learning from Examples: Induction – Explanation based Learning – Discovery – Analogy – Formal Learning Theory – Neural Net Learning and Genetic Learning
3.2 Parallel and Distributed AI
Psychological Modelling – Parallelism in Reasoning Systems – Distributed Reasoning Systems

UNIT-IV :

4.1 Deep Learning Frameworks and AI Methodologies
Working – Framework – programming Languages – applications – optimization – fuzzy inference systems – artificial creativity – additional AI methodologies – glimpse into the future
4.2 Building DL network using MXNet, TensorFlow and Keras
Core components – MXNet, TensorFlow and Keras in action – Summary and Visualization

UNIT-V:

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, Case studies, Real time projects
Skills acquired from this course	AI methodologies & Techniques for data science related problems
Recommended Text	Kevin Night, Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill2008. (Unit- 1, 2, 3)
Reference Books	Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited, 2016. Prolog Programming for Artificial Intelligence (International Computer Science Series), Addison-Wesley Educational Publishers Inc; 4th edition, 2011 By Ivan Bratko
Website and **e-Learning Source**	http://www.aispace.org/index.html https://www.britannica.com/technology/artificial-intelligence https://www.sas.com/en_in/insights/analytics/what-is-artificial-intelligence.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand and identify problems that are amenable to solution by AI methods
CLO2	Analyse and apply appropriate AI methods to solve a given problem.
CLO3	Analyse and formalize a given problem in the language/framework of different AI and learning methods
CLO4	Evaluate the AI methodologies and DL networks
CLO5	Develop AI framework to tackle projects in our increasingly complex world

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO	15	15	15	10	5	5

Title of the Course	IMAGE RECOGNITION						
Paper Number	Paper II						
Category	Elective VI	Year	II	Credits	3	Course Code	23PDSE17
		Semester	IV				
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		4		1	0	5	
Pre-requisite		Knowledge on Mathematics and Programming Language like python					
Objectives of the Course		To understand the fundamentals of real time images, image transformations, detect edges and recognize objects in the image					
Course Outline		**UNIT-I :** **1.1 Introduction** The Human Vision System - Practical Applications of Computer Vision - The Future of Computer Vision **1.2 Images** The Simple Pinhole Camera Model - Images - Sampling- Quantization- Color Images- Noise – Smoothing					
		UNIT-II : **2.1 Histograms** 1D Histograms - Histogram/Image Equalization- Histogram Comparison-k-means Clustering **2.2 Binary Vision** Thresholding- Threshold Detection Methods- Mathematical Morphology					
		UNIT-III : **3.1 Geometric Transformations** Affine Transformations - Perspective Transformations – Interpolation **3.2 Edges** Edge Detection - Contour Segmentation - Hough Transform					
		UNIT-IV : **4.1 Features** Moravec Corner Detection - Harris Corner Detection - FAST Corner Detection- SIFT - Recognition					

	UNIT-V:
	5.1 Recognition Template Matching - Chamfer Matching - Statistical Pattern Recognition - Cascade of Haar Classifiers - Other Recognition Techniques - Performance **5.2 Vision Problems** Abandoned and Removed Object Detection - Traffic Lights - Real Time Face Tracking - Road Sign Recognition - License Plates
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, Case studies, Real time project analysis
Skills acquired from this course	Real time research projects related to Image recognition
Recommended Text	Kenneth Dawson. A Practical Introduction to Computer Vision with OpenCV. John Wiley & Sons Ltd, 2014.

Reference Books	David A. Forsyth, Jean Ponce. Computer Vision: A Modern
	    Approach. Pearson Edition,2015.
	Jan Erik Solem. Programming Computer Vision with Python: Tools
	    and Algorithms for Analyzing Images. O'Reilly Media, 2012.
	Richard Szeliski. Computer Vision: Algorithms and Applications.
	    Springer Publications, 2011.
	Simon J. D. Prince. Computer Vision: Models, Learning, and
	    Inference. Cambridge University Press,2012.

Website and **e-Learning Source**	https://www.cs.toronto.edu/~urtasun/courses/CV/lecture01.pdf https://www.cl.cam.ac.uk/teaching/0809/CompVision/CompVisNotes.pdf

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand fundamentals of images, Computer Vision and Geometric transformations
CLO2	Apply Histograms in real time images and recognize features
CLO3	Analyse the edge detection techniques

CLO4	Evaluate the vision related problems in further research
CLO5	Develop real time projects related image recognition

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to eachPSO	15	15	15	10	5	5

Title of the Course	DEEP LEARNING						
Paper Number	**Paper III**						
Category	Elective VI	**Year**	II	**Credits**	3	**Course Code**	**23PDSE18**
		Semester	IV				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		1	--	5	
Pre-requisite	Mathematics, Machine Learning and Programming						
Objectives of the Course	To provide fundamental knowledge of neural networks and deep learning						
Course Outline	**UNIT-I :** **Introduction to Artificial Neural Networks** 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** Shallow neural networks- Perceptron Networks-Theory-Perceptron Learning RuleArchitecture-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** 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** 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** Introduction - Features of Auto encoder Types of Autoencoder Restricted Boltzmann Machine- Boltzmann Machine - RBM Architecture -Example - Types of RBM.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, case studies, real time projects (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge and Skill for real time research problems
Recommended Text	S.N.Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley-India, 3rd Edition, 2018. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, Deep Learning using Python, Wiley-India, 1st Edition, 2019.
Reference Books	Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, September 2018. Francois Chollet, Deep Learning with Python, Manning Publications; 1st edition,2017 John D. Kelleher, Deep Learning (MIT Press Essential Knowledge series), The MIT Press, 2019.
Website and **e-Learning Source**	https://onlinecourses.nptel.ac.in/noc22_cs22/preview https://arxiv.org/abs/1506.06579 https://arxiv.org/abs/1605.06211 https://cs230.stanford.edu/lecture/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the major technology trends in neural networks and deep learning
CLO2	Analyse neural networks and fully connected deep neural networks
CLO3	Apply neural networks and fully connected deep neural networks
CLO4	Evaluate efficient (vectorized) neural networks and deep learning for real time application
CLO5	Build efficient (vectorized) neural networks and deep learning for real time application

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to eachPSO						

SKILL ENHANCEMENT COURSES LIST (SEC)

Course code	23PDSSP01	CLOUD COMPUTING LAB	L	T	P	C
Core/Elective/Supportive		**Supportive**			4	4
Pre-requisite		Basic Programming using Cloud				

Course Objectives:

The main objectives of this course are to:

1. This course covers the basic data structures like Stack, Queue, Tree , List.

2. This course enables the students to learn the applications of the data structures using various techniques

3. It also enable the students to understand C++ language with respect to OOAD concepts

4. Application of OOPS concepts

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the concepts of object oriented with respect to C++	K1,K2
2	Able to understand and implement OOPS concepts	K3,K4
3	Implementation of data structures like Stack, Queue, Tree , List using C++	K4,K5
4	Application of the data structures for Sorting, Searching using different techniques.	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF PROGRAMS	60 hours

1. Working with Google Drive to make spreadsheet and notes.

2. Launch a Linux Virtual Machine.

3. To host a static website

4. Exploring Google cloud for the following a) Storage b) Sharing of data c) manage your calendar, to-do lists, d) a document editing tool

5. Working and installation of Google App Engine

6. Working and installation of Microsoft Azure

7. To Connect Amazon Redshift with S3 bucket

8. To Create and Query a NoSQL Table

Expert lectures, online seminars – webinars

	Total Lecture hours	**60 hours**

Text Books

1	Michael Miller, "Cloud Computing", Pearson Education, New Delhi, 2009.

Reference Books

1	Anthony T. Velte, "Cloud Computing: A Practical Approach", 1st Edition, Tata McGraw Hill Education Private Limited, 2009.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/106/105/106105167/
2	https://www.tutorialspoint.com/cloud_computing/index.htm
3	https://www.javatpoint.com/cloud-computing-tutorial

Mapping with Programming Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	23PDSSP02	DIGITAL IMAGE PROCESSING Using MATLAB	L	T	P	C
Core/Elective/Supportive		**Supportive**			4	4
Pre-requisite		Basic Programming of Image Processing & an intro to MATLAB				

Course Objectives:

The main objectives of this course are to:

1. To understand the basics of Digital Image Processing fundamentals, image enhancement and image restoration techniques

2. To enable the students to learn the fundamentals of image compression and segmentation

3. To understand Image Restoration & Filtering Techniques

4. Implementation of the above using MATLAB

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	To write programs in MATLAB for image processing using the techniques	K1,K2
2	To able to implement Image Enhancements & Restoration techniques	K2,K3
3	Capable of using Compression techniques in an Image	K3,K4
4	Must be able to manipulate the image and Segment it	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF PROGRAMS	60 hours

1. Implement Image enhancementTechnique.

2. Histogram Equalization

3. ImageRestoration.

4. Implement ImageFiltering.

5. Edge detection using Operators (Roberts, Prewitts and Sobelsoperators)

6. Implement image compression.

7. Image Subtraction

8. Boundary Extraction using morphology.

9. Image Segmentation

	Total Lecture hours	60 hours

Text Books	
1	Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", Second Edition,

	PHI/Pearson Education.
2	B. Chanda, D. Dutta Majumder, "Digital Image Processing and Analysis", PHI, 2003.

	Reference Books
1	Nick Efford, "Digital Image Processing a practical introducing using Java", Pearson Education, 2004.

	Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
1	https://nptel.ac.in/courses/117/105/117105135/
2	https://www.tutorialspoint.com/dip/index.htm
3	https://www.javatpoint.com/digital-image-processing-tutorial

Mapping with Programming Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Professional Competency Skill Enhancement Course

Course code	23PDSPC01	Soft Skill Development Lab	L	T	P	C
Core/Elective/Supportive		**Supportive**			4	2

Course Objectives:

The main objectives of this course are to:
1. To enable students to gain basic communication skills in professional and social contexts effectively.
2. To acquire useful words and apply them in situational context.
3. To develop listening and reading skills through comprehension passages
4. To enrich the leadership qualities and interpersonal communication
5. To enhance essential characteristics in writing

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Improves the professional communication skills	K1-K6
2	Apply useful words in the correct situation	K1-K6
3	Improves the listening and reading skills	K1-K6
4	Acquire the leadership qualities	K1-K6
5	Improves the writing ability	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

EXERCISES	75 hours

1. Characteristics of Technical Writing
2. Development of Employability Skills
3. Vocabulary Development
4. Sentence Completion
5. Error Spotting
6. Interpretation of Verbal Analogy
7. Interpretation of Reading (Comprehension -Conception)
8. Interpretation of Reading (Comprehension -Reasoning)
9. Practice for writing E-mails/Technical Blogs/Forums
10. PPT Preparation / Demonstration of Technical Presentation
11. Preparation of Resume
12. Preparation for Job Interviews / Mock Interview Section
13. Group Discussion Skills
14. Developing Listening Skill(Comprehension)
15. Practice for Short Speeches / Situational Conversation
16. English through Mass Media
17. Essential Grammar

18. Communicating and collaborating with peer members		
19. Team Empowerment		
20. Persuasive Communication		
Expert lectures, online seminars – webinars		

Text Books
1. Uma Narula, "Development Communication: Theory and Practice", Revised Edition, Har-Aanad Publication, 2019.
2. Annette Capel and Wendy Sharp, "Cambridge English: Objective First", Fourth Edition, Cambridge University Press, 2013.
3. Emma Sue-Prince, "The Advantage: The 7 Soft Skills You Need to Stay One Step Ahead", First Edition, FT Press, 2013.
4. Guy Brook-Hart, "Cambridge English: Business Benchmark",Second Edition, Cambridge University Press, 2014.
5. Norman Lewis, "How to Read Better & Faster", Binny Publishing House, NewDelhi, 1978.
Reference Books
1. Michael McCarthy and Felicity O'Dell, "English Vocabulary in Use:100 Units of Vocabulary Reference and Practice", Cambridge UniversityPress,1996.
2. Murphy, Raymond, "Intermediate English Grammar", Second Edition, Cambridge University Press, 1999.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	M	S	S	S	S	-
CO2	S	M	S	S	S	M	S	S	S	-
CO3	S	S	S	S	S	S	S	S	S	-
CO4	S	M	M	S	M	L	S	S	S	-
CO5	M	S	M	L	S	M	S	S	S	-

S- Strong; M-Medium; L-Low

Course code	23PDSPC02	Data Visualization Lab	L	T	P	C
Core/Elective/Supportive		**Supportive**			4	2

Course Objectives:

The main objectives of this course are to:
1. To learn the basic functions and operations of Excel and tableau
2. To explore to design, build, and deploy various charts for applications,
3. To comprehend, design and deploy the label and heat map
4. To understand and deploy dashboard
5. To understand the functions of tableau for data process.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Enable to create and apply Spread sheet and Tableau for various data processing	K1-K6
2	Gains knowledge to create and design various visualization tools in Excel and Tableau.	K1-K6
3	Comprehend, create and deploy labels and heat map.	K1-K6
4	Enable to create and apply dashboard for various data processing	K1-K6
5	Illustrate and apply data visualization tool for any data set	K1-K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

LIST OF PROGRAMS	75 hours

Note: Use the following Dataset
http://www.tableau.com/sites/default/files/training/global_superstore.zip
Implement the following using Excel

1. Create Pie chart for Sales and Sales % by Country (sorted in descending order)
2. Create Bar chart for Sales by Country by Year (rounded to nearest thousand and sorted by Grand Total)
3. Create Line char for Sales by Ship Mode (First Class, Same Day, Second Class and Standard Class)
4. Create Scatter chart for Sales by Ship Mode by Country (rounded to the nearest dollar and sorted by First Class)
5. Create heat map for Sales by Category by Sub-Category (in thousands and sorted by sales value in descending order)
6. Design and create the label for vendor list
7. Design and create the dash board

Implement the following using Tableau

8. Sales by Ship Mode (First Class, Same Day, Second Class and Standard Class)
9. Sales by Ship Mode by Country (rounded to the nearest dollar and sorted by First Class)
10.   Sales by Category by Sub-Category (in thousands and sorted by sales value in descending order)

	Expert lectures, online seminars – webinars

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	M	S	-	-	-	-
CO2	S	M	S	S	S	M	-	-	-	-
CO3	S	S	S	S	S	S	-	-	-	-
CO4	S	M	M	S	M	L	-	-	-	-
CO5	M	S	M	L	S	M	-	-	-	-

S- Strong; M-Medium; L-Low

List of **Extra Disciplinary Courses** (Non-Major Electives) offered to other PG programmes

Course code	23PDSED01	PRINCIPLES OF INFORMATION TECHNOLOGY	L	T	P	C
Core/Elective/Supportive		**Supportive**	4			4

Course Objectives:

The main objectives of this course are to:

1. To learn the basic concept and skills associated with information technology

2. To know the Computer hardware and software technologies

3. To gain the knowledge of organizing data

4. To assess the current role of Information Science in an organization

5. To understand how IT relates to organizational goals

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the basics of information technology	K1,K2
2	Gain the knowledge of Hardware and Software technologies	K2
3	Learn the method of organizing data	K3,K4
4	Assess the role of Information Science to an organization.	K5
5	Understanding the role of IT in organizations	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

	Unit:1	12 hours

Business Environment: Business and Information technology – business in the information age– about information technology–what is an information system– Information Technology in the Modern Organization

	Unit:2	12 hours

Computer Hardware – Significance of Hardware – Central Processing Unit– Computer Memory – Computer Hierarchy – Input Technologies – Output Technologies. Computer Software: Software History and Significance–System Software–Application Software–Software issues–Programming languages–Enterprise Software.

	Unit:3	12 hours

Managing Organizational Data and Information: Basics of Data arrangement and Access – Traditional file environment – modern approach: database management systems – logical data models – data warehouses – Networks– Internet- Evolution of the Internet –Operation of the Internet– WWW-Intranets and Extranets.

	Unit:4	12 hours

Functional, Enterprises, and Inter organizational Systems: Information system to support business functions – transaction processing information systems – accounting and finance system – marketing and sales system – production and operations management system –Integrated information system and enterprises resource planning–inter organizational/Global information system. –Electronic Commerce

	Unit:5	10 hours

Information Systems Development: Information system planning–Traditional systems development life cycle – alternative methods for system development –system development outside the IS department – building Internet and Intranet applications –Implementing: Ethics, Impacts and Security.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		

	Total Lecture hours	60 hours

Text Books

1	Turban, Rainer, Potter "Introduction to Information Technology," Second edition, Wiley India, 2007.

Reference Books

1	V. Rajaraman, "Introduction to Information Technology, "Prentice Hall of India,2007

Mapping with Programming Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	23PDSED02	FUNDAMENTALS OF COMPUTERS AND COMMUNICATIONS	L	T	P	C
Core/Elective/Supportive		Supportive	4			4

Course Objectives:

The main objectives of this course are to:

1. Know the basics of Computers

2. Learn the internal Components of Computers

3. Understand the OS and its types

4. Study the basics of networks and Internet

5. Get a clear idea on DBMS and its concepts

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Know the basics and internal parts of Computers	K1,K2
2	Gain the knowledge on OS and its types	K2
3	Understand the basics of networks and Internet	K3,K4
4	Learn the databases and DBMS concepts	K5
5	Understand the role of RDBMS in IT	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

	Unit:1	12 hours

Introduction: What is computer – Components of Computers – Advantages and Disadvantages of using computers – Computer Software – Categories of Computers - Elements of information systems. The Components of the Systems Unit: Processor – Data representation – Memory – Mobile Computers and Devices.

	Unit:2	12 hours

Input and Output Device: What is input – what are input devices – keyboard – pointing device – mouse – other pointing devices – Voice input –Digital Cameras – Video input – Scanners and Reading devices Terminals – Biometric input - Input devices for physically challenged users-Output: What is output – display devices – Monitors – Printers –Speakers, Headphones and Ear phones – output device for physically challenged users – Storage devices.

	Unit:3	12 hours

Operating Systems and Utility Programs: System software – Operating system – Operating system functions – types of operating systems – standalone operating systems–network operating systems – embedded operating system. Application Software: Application software – Business software – Graphics and Multimedia Software–Application software for Communication.

	Unit:4	12 hours

Internet and World Wide Web: Internet – History of the Internet – How the Internet works –WWW–E-commerce–Communications and Networks: Communications – Uses of Computer Communications – Networks – Communication software – Communication devices – Communications Channel – Physical transmission media and Wireless transmission media.

	Unit:5	10 hours

Database Management: Databases, Data and Information, The Hierarchy of data–Maintaining data – File processing versus databases – database management systems–relational, object oriented and multi dimensional databases – web databases – database administration. Computer Security: Computer security risks – Internet and network attacks –Unauthorized access and use.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	60 hours

Text Books

1	Gary B. Shelly, Thomasj. Cashman, Misty E.Vermaat, "Introduction to Computers,"Cengage Learning, 2008

Reference Books

1	Reema Thareja, "Fundamentals of Computers", Oxford Univ. Press,2015
2	Deborah Morley, Charles S.Parker, "Understanding Computers-Today and Tomorrow",14th Edition, Thomson Course Technology, 2012
3	Alexis Leon, Mathew's Leon, "Fundamentals of Computer Science and Communication Engineering", Vikas Publishing House, New Delhi, 1998.

Mapping with Programming Outcomes									
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	23PDSED03	**E - COMMERCE**	**L**	**T**	**P**	**C**
Core/Elective/Supportive		**Supportive**	4			4

Course Objectives:

The main objectives of this course are to:

1. Know the mercantile and consumer process model

2. Understand the Consumer's and Merchant's perspective

3. Understand the Electronic payment system

4. Earn an in depth idea on electronic data interchange

5. Gain the knowledge on Internet, growth of internet and its commercial uses

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Learn the introduction on e-commerce	K1,K2
2	Understand the mercantile and consumer process models	K2
3	Analyse the consumers and merchant's perspective on e-commerce	K3,K4
4	Getting an idea on Electronic Data Interchange	K5
5	Gaining the knowledge on Internet	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**12 hours**

Electronic Commerce – Electronic Commerce Frame work – The Anatomy of Electronic Commerce Applications - Electronic Equipment Consumer Applications - Electronic Commerce Organization Applications - Components of I-Way – Network Access Equipment.

Unit:2	**12 hours**

Architecture Framework for Electronic Commerce- World Wide Web as the Architecture – Consumer Oriented Applications – Mercantile Process Models – Mercantile Models from the Consumer's Perspective and Merchant's Perspective.

Unit:3	**12 hours**

Electronic Payment Systems: Types of Electronic Payment Systems – Digital Token based Electronic Payment Systems–Smart Card and Credit Card Based Electronic Payment Systems – Risk and Electronic Payment Systems – Designing Electronic Payment Systems.

	Unit:4	12 hours
	Electronic Data Interchange – EDI Applications in Business – EDI: Legal, Security and Privacy issues EDI and Electronic Commerce – Standardization and EDI – EDI Software Implementation.	
	Unit:5	**10 hours**
	Internet and World Wide Web: origin of the Internet – New uses for the Internet – Commercial use of the Internet–Growth of the Internet – Advertising on the Internet.	
Unit:6	**Contemporary Issues**	**2 hours**
	Expert lectures, online seminars – webinars	
	Total Lecture hours	**60 hours**

Text Books

1	Kalakota and Whinston, "Frontiers of Electronic Commerce", Pearson Education, 2004.
2	Gray P.Scheider, "Fourth Annual Edition Electronic Commerce", Thomson Course Technology, 2003.

Reference Books

1	Kamalesh K. Baja, Debjani Nag, "E-Commerce–The Cutting Edge of Business", TMH Publications, 2005.
2	Agarwala, K.N, Deeksha Agarwala, "Business on the Net: What's and How's of E-Commerce;" Macmillan, New Delhi.
3	Parag Diwan, Sunil Sharma, "Electronic Commerce: A Manager's Guide to E-Business", Excel books, 2005.

Mapping with Programming Outcomes									
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

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