M.Sc. DATA SCIENCE
(2026 – 2028)

(For candidates admitted in the academic year 2026-27)
HOLY CROSS COLLEGE (AUTONOMOUS) Tiruchirappalli - 620002.
Affiliated to Bharathidasan University
Nationally Accredited (4th Cycle) with 'A++' Grade (CGPA 3.75/4) by NAAC
College with Potential for Excellence.
PG DEPARTMENT OF DATA SCIENCE
Programme: M. Sc. Data Science

PO. No	Programme Outcomes *Upon completion of the M.Sc. Data Science Degree Programme, the graduate will be able to*
PO-1	**Disciplinary Knowledge:** Exhibit a profound mastery of theories, methodologies, and tools in the Data Science field.
PO-2	**Research Related skills:** Utilize independent research to create findings and solutions to address the real-time problems.
PO-3	**Problem Solving:** Apply employability skills to confidently navigate in the job market and excel in Visualizing Tools in diverse professional settings.
PO-4	**Moral and ethical awareness:** Demonstrate a strong commitment to ethical and moral values, actively engage in activities that promote Emerging Technologies in Data Science.
PO-5	**Lifelong Learning and Communication Skills:** Embrace a commitment to professional development, possessing the Technical Skills to adapt to the evolving trends, engage in self-directed learning and continuously enhance their expertise.
PO-6	**Critical Thinking:** Apply the mathematical techniques, software development strategies, tools and organize information system and services to draw solution to complex and multidisciplinary scenario.
PO-7	**Self-directed Learning:** Design solutions for Web Technologies with digitalized environmental considerations.
PO-8	**Scientific Reasoning:** Enhance AI models for predictive analytics to forecast trends, identify patterns, and anticipate future outcomes, enabling proactive decision-making and risk mitigation strategies.
PO-9	**Reflective Thinking:** Employ learning to personalize innovative experiences in concept such as Machine learning and Deep learning.

PSO. No	Programme Specific Outcomes *Upon completion of these courses the learners would have the*
PSO-1	Develop computer programs in the fields related to Artificial Intelligence, Advanced Data Science techniques for efficient design of computer- based systems of varying complexity.
PSO-2	Implement ethical sustainable solutions in the areas of Data Science using programming languages, database systems, machine learning and big data analytics tools.
PSO-3	Apply the Knowledge in the field of data science and experience an environment conducive in cultivating skills for successful career, entrepreneurship and higher studies in Robotics.

(For candidates admitted in the academic year 2026 - 2027)
HOLY CROSS COLLEGE (AUTONOMOUS), TIRUCHIRAPPALLI
SCHOOL OF MATHEMATICAL COMPUTATIONAL AND INFORMATION SCIENCES
PG DEPARTMENT OF DATA SCIENCE
CHOICE BASED CREDIT SYSTEM
LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF)
PG COURSE PATTERN
Programme: M. Sc. Data Science

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
I	Core Course 1	Mathematics for Data Science	P26DS1CCT01	6	6	100
	Core Course 2	Statistics For Data Science	P26DS1CCT02	6	6	100
	Core Course 3	Python Programming	P26DS1CCT03	5	5	100
	Core Course 4	Python Programming - Lab	P26DS1CCP04	4	2	100
	Elective Course 1 (Discipline Specific)	R for Data Analytics / Internet of Things	P26DS1ECT01/ P26DS1ECT02	4	3	100
	Elective Course 2 (Discipline Specific)	R for Data Analytics – Lab/ Internet of Things - Lab	P26DS1ECP03/ P26DS1ECP04	4	2	100
		Value Education		1		
	Total			**30**	**24**	**600**

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
II	Core Course 5	Foundations of Machine Learning	P26DS2CCT05	5	5	100
	Core Course 6	Machine Learning -Lab	P26DS2CCP06	4	2	100
	Core Course 7	Database Technology	P26DS2CCT07	5	5	100
	Core Course 8	Database Technology - Lab	P26DS2CCP08	4	2	100
	Elective Course 3 (Discipline Specific)	Exploratory Data Analysis/ Social Media Analytics	P26DS2ECT05/ P26DS2ECT06	4	3	100
	Elective Course 4 (Generic)	Statistical Inference/ Information Sources in Science and Technology/ Cyber Security	P26MA2ECT07/ P26LS2ECT07/ P26CA2ECT07	4	3	100
	SEC I	Non Major Elective I		3	2	100
		Massive Open Online Course (MOOC)	P25EXCONC01		2(EC)	
		Internship (30 hours)	P25EX2INT01		2(EC)	100
		Value Education		1		
	Total			**30**	**22+4**	**700+100**

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
III	Core Course 9	Deep Learning	P26DS3CCT09	5	5	100
	Core Course 10	Deep Learning - lab	P26DS3CCP10	4	2	100
	Core Course 11	Full Stack Development	P26DS3CCT11	4	4	100
	Core Course 12	Full Stack Development-Lab	P26DS3CCP12	4	2	100
	Core Course 13	Industrial Module - Business Analytics	P26DS3CCT13	6	6	100
	Elective Course 5 (Discipline Specific)	Blockchain Technology/ Cyber Security Analytics	P26DS2ECT08/ P26DS2ECT09	4	3	100
		Internship (30 hours)	P26DS3INT01	-	2	100
	SEC 2	Non Major Elective 2		3	2	100
	Total			**30**	**26**	**800**

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
IV	Core Course 14	Advanced Web Technology	P26DS4CCT14	5	5	100
	Core Course 15	Advanced Web Technology - Lab	P26DS4CCP15	4	2	100
	Core Course 16	Data Visualization	P26DS4CCT16	4	4	100
	Core Course 17	Data Visualization Tools – Lab	P26DS4CCP17	4	2	100
		Project with Viva Voce	P26DS4DIS01	6	6	100
	Elective Course 6 (Discipline Specific)	Advanced Computing Technologies/ Data Engineering	P26DS4ECT10 / P26DS4ECT11	4	3	100
	SEC 3	Professional Competency – Federated Learning	P26DS4SET03	3	2	100
	Extension Activity	Centre for Rural Development and Extension (CRDE & RESCAPES)	P24EX4RES01		2(EC)	100
	Self-Study Course	Professional Ethics	P26DS4SST01		2(EC)	100
	Total			**30**	**24+4**	**700+200**
	Grand Total			**120**	**96+8**	**2800+300**

ELECTIVE COURSES OFFERED BY THE DEPARTMENT

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
II	Elective Course 4 (Generic)	Python for Data Analytics	P26DS2ECT07	4	3	100

NME COURSES OFFERED BY THE DEPARTMENT FOR PG

Semester	Course	Title of the Course	Code	Hrs/Wk	Credits	Marks
II	Non Major Elective 1	Visual Analytics for Business Intelligence – Lab	P26DS2SEP01	3	2	100
III	Non Major Elective 2	Generative AI –Lab	P26DS3SEP02	3	2	100

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**CORE COURSE 1: MATHEMATICS FOR DATA SCIENCE**
Code	**P26DS1CCT01**
Course Type	**Theory**
Semester	**1**
Hours/Week	**6**
Total Hours	**90**
Credits	**6**
Marks	**100**

CONSPECTUS

To introduce the fundamental concepts of linear algebra such as vectors, matrices, systems of linear equations, and subspaces.

COURSE OBJECTIVES

1. To recall the fundamental mathematical concepts required for data science.
2. To explore the four fundamental subspaces and their significance in solving linear systems, analyzing data, and understanding the structure of matrices
3. To investigate the concepts of orthogonality and the role of determinants in matrix properties and solving linear equations
4. To gain proficiency in Eigen values and Eigen vectors and their importance in data science applications
5. To experiment the behavior of linear transformations

UNIT I: Vectors and Matrices **(12 Hrs)**

1.1 Vectors and Linear Combinations - Lengths and Angles from Dot Products –System of Linear Equations

1.2 The Idea of Elimination- Elimination Using Matrices

1.3 Rules for Matrix Operations - Elimination - Factorization: $A = LU$

1.4 Transposes and Permutations

Extra Reading / Key Words: Vector operations, matrix operations, linear equations, LU factorization.

UNIT II: Subspaces **(12 Hrs)**

2.1 Vector Spaces and Subspaces- Spaces of Vectors- The Nullspace of matrix A: Solving $Ax = 0$ and $Ax = 0$

2.2 The Complete Solution to $Ax = b$ - Linearly Independence,

2.3 Basis and Dimension

Extra Reading / Key Words: Basis Vectors, Matrix Dimension.

UNIT III: Orthogonality of Vectors and Subspaces **(12 Hrs)**

3.1 Orthogonality of the Subspaces- Orthogonal Complement – Projections- Projections onto Lines and Subspaces

3.2 Least Squares Approximations -Fitting a Straight line- Fitting a Parabola - Orthonormal Bases and Gram-Schmidt process

3.3 Determinants – The Properties of Determinants- Permutations and Cofactor Cramer's Rule- Areas and Volumes by Determinants

Extra Reading / Key Words: least squares, Inner Product Spaces

UNIT IV: Eigen Values and Eigenvectors **(12 Hrs)**

4.1 Finding Eigen values and Eigenvectors of a Matrix - their properties
4.2 Diagonalizing a Matrix – Systems of Differential Equations
4.3 Symmetric Matrices- Positive Definite Matrices
Extra Reading / Key Words: Matrix Diagonalization, Spectral Theorem

UNIT V: Linear Transformations **(12 Hrs)**

5.1 The Linear Transformation
5.2 The Matrix of a Linear Transformation
5.3 The Search for a Good Basis
Extra Reading / Key Words: Change of Basis, Coordinate Transformation.

Note: Texts given in the Extra Reading /Key Word must be tested only through Assignment and seminars.

PRESCRIBED TEXT BOOK

1. Gilbert Strang. (2023). Introduction to Linear Algebra (6th Ed.). Wellesley - Cambridge Press.
   UNIT I: Chapter 1, 2
   UNIT II: Chapter 3
   UNIT III: Chapter 4, 5
   UNIT IV: Chapter 6
   UNIT V: Chapter 8

SUGGESTED READINGS

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

WEB REFERENCES

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

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	CognitiveLevel (K1-K5)
CO 1	Recall and reproduce fundamental mathematical concepts relevant to data science	**K1**
CO 2	Explain the underlying principles of mathematical techniques and interpret various fundamental subspaces	**K2**
CO 3	Apply and utilize eigenvalue and eigenvector concepts to analyze the behavior of linear transformations and diagonalizable matrices	**K3**
CO 4	Analyze and evaluate different linear transformations in terms of their effects on vector spaces and subspaces	**K4**
CO 5	Evaluate the impact of linear transformations on data quality, interpretability, and computational complexity in various data science scenarios	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	H	H	M	M	H	L	L	M	M
CO 2	H	H	M	H	M	L	M	M	M
CO 3	H	H	H	H	H	L	M	M	M
CO 4	H	H	M	H	H	M	M	M	L
CO 5	H	H	H	H	H	M	H	M	M

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	H	M
CO 3	H	H	H
CO 4	M	H	H
CO 5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**CORE COURSE 2: STATISTICS FOR DATA SCIENCE**
Course Code	**P26DS1CCT02**
Course Type	**Theory**
Semester	**I**
Hours / Week	**6**
Total Hours	**90**
Credits	**6**
Marks	**100**

CONSPECTUS

To develop knowledge about fundamental concepts in probability and statistics. To analyze the characteristics of data by using relevant statistical tools

COURSE OBJECTIVES

1. To understand various methods of collection of data and representing them through graphs.
2. To describe various measures of dispersion and correlation
3. To discuss various types of distribution functions, calculate and interpret expected results
4. To apply the methods of estimating a parameter
5. To evaluate probability, conditional probabilityand its axiom and theorems.

UNIT I – Collection and Presentation of Data (18 Hrs)

1.1 Origin and development of statistics – scope – limitations – misuse of statistics.
1.2 Types of data and measurements – methods of data collection – primary and secondary data.
1.3 Presentation of data by tables and graphs – construction of frequency distributions – histogram and frequency polygon – cumulative frequency curve.
1.4 Application of data collection in data science.

Use Case: Applications of Healthcare Data Analysis Sectors.

Extra Reading / Key Words: ***Business statistics, Functions and distrust of statistics.***

UNIT II – Measures of Central Tendency (18 Hrs)

2.1 Mean – Median – Mode – computation for discrete and continuous series.
2.2 Measures of dispersion – range – mean deviation – quartile deviation – standard deviation. Correlation – scatter diagram – Karl Pearson's coefficient – rank correlation.
2.3 Application of correlation in data science.
2.4 **Use Case:** Correlation in Business Monitoring.

Extra Reading / Key Words: Grouped data, Gaussian distribution, Laplace distribution.

UNIT III – Random Variables, Expectation and Special Distributions (18 Hrs)

3.1 Distribution functions – discrete and continuous random variables – two-dimensional random variables.
3.2 Expectation – properties – variance – covariance.
3.3 Special distributions – Gamma, Chi-Square, t, and F distributions.
3.4 Application of Chi-Square test in machine learning.

Use Case: Chi-Square Test in Online Shopping Preferences.

Extra Reading / Key Words: *Multinomial distribution, compound marginal distribution, probability distribution fitting*.

UNIT IV – Estimation **(18 Hrs)**

4.1 Characteristics of estimators – unbiasedness, consistency, efficiency.
4.2 Cramer-Rao inequality – methods of estimation – method of moments – maximum likelihood.
4.3 Confidence interval and confidence limits.
4.4 Applications of estimation in data science.

Use Case: Estimation in Environmental Science.

Extra Reading / Key Words: *Multivariate Cramer-Rao bound, log-normal distribution, mean-squared-error version.*

UNIT V – Basics and Elements of Probability **(18 Hrs)**

5.1 Classicaldefinition – addition and multiplication theorems odds in favour and against events.
5.2 Axiomatic approach – axioms of probability – conditional probability – Baye's theorem.
5.3 Independent events – multiplicative law of probability.
5.4 Applications of probability in machine learning.

Use Case: Application of Probability in Data Analysis Problems

Extra Reading / Key Words: *Stock market, Tree diagram, Mutually exclusive events.*

Note: Texts given in the Extra Reading /Key Word must be tested only through Assignment and seminars.

PRESCRIBED TEXT BOOKS

1. Treatment and content as in Pillai R.S. N, Bagavathi. V, Statistics, S.Chand and Company, New n Delhi, 2007
   UNIT I: Chapter 1,4,6,7 & 8
   UNIT II: Chapter 9, 10 &12
2. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.
   UNIT III: Chapter 5 (5.1-5.5), **C**hapter 6(6.1-6.6), Chapter 15(15.1-15.3)
   UNIT IV: Chapter 17 (17.1-17.3, 17.6)
3. Vittal. P.R, Mathematical Statistics, Margham Publishers, Chennai, 2002.
   UNIT V: Chapter 1

SUGGESTED READINGS

1. Arora. S, Sumeet Arora, Comprehensive Statistical Methods, S. Chand and Company Ltd, New Delhi, 2002.
2. Jim Frost, Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries, 2020.
3. Gupta. S.P, Statistical Methods, Sultan Chand & Sons, New Delhi 2006.Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
4. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier Academic Press, UK, Fifth Edition, 2023.

WEB REFERENCES

1. https://www.simplilearn.com/tutorials/statistics-tutorial/what-is-correlation-in-statistics.
2. https://www.geeksforgeeks.org/ml-chi-square-test-for-feature-selection/?ref=ml_lbp.
3. https://www.analyticsvidhya.com/blog/2021/03/quick-guide-to-estimation/.
4. https://www.datasciencecentral.com/understanding-the-applications-of-probability-in-

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K5)
CO 1	Identify the fundamental concepts of Python programming, including features, data types, operators, and control statements.	**K1**
CO 2	Explain the use of Python data structures and basic object-oriented programming concepts.	**K2**
CO 3	Apply Python programming and NumPy techniques to solve computational and numerical problems.	**K3**
CO 4	Analyze and manipulate datasets using NumPy arrays and Pandas operations such as aggregation, comparison, and grouping.	**K4**
CO 5	Evaluate and interpret data by creating and customizing visualizations using Matplotlib and Seaborn.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyse, K5=Evaluate

MAPPING

PO–CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	H	L	L	L	M	M	L	L	L
CO2	H	L	M	L	M	M	L	L	L
CO3	H	M	H	L	M	H	L	M	L
CO4	H	H	H	L	M	H	L	H	M
CO5	H	M	H	M	H	H	L	H	H

PSO–CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO1	M	L	L
CO2	M	L	L
CO3	H	M	M
CO4	H	H	M
CO5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**CORE COURSE 3: PYTHON PROGRAMMING**
Code	**P26DS1CCT03**
Course Type	**Theory**
Semester	**1**
Hours/Week	**5**
Total Hours	**75**
Credits	**5**
Marks	**100**

CONSPECTUS

To understand and apply Python programming concepts including data structures, numerical computing, data analysis, and visualization to solve real-world problem.

COURSE OBJECTIVES

1. To recall the basic concepts of Python programming, including features, data types, operators, and control statements.
2. To explain Python data structures such as strings, lists, tuples, sets, and dictionaries, along with fundamental object-oriented concepts.
3. To apply Python programming techniques and NumPy functions to solve computational and numerical problems.
4. To analyze data using NumPy arrays and Pandas using operations such as aggregation, comparison, and grouping.
5. To evaluate and interpret data through effective visualization using Matplotlib and Seaborn by selecting appropriate plots and customization techniques.

UNIT I: Introduction To Python **(15 Hrs)**

1.1 Features of Python - Datatypes in python
1.2 Operators in python
1.3 Input and Output
1.4 Control Statements

Extra Reading/Key words*:* *Understanding Python Libraries (NumPy, Pandas, Matplotlib, Scikit-learn)*

UNIT II: Strings And Characters **(15 Hrs)**

2.1 Creating Strings
2.2 Lists and Tuples – Set - Dictionaries
2.3 Introduction to oops

Extra Reading/Key words*:* *List Comprehension, Dictionary Comprehension, Inheritance and Polymorphism*

UNIT III: Introduction To Numpy **(15 Hrs)**

3.1 Functions
3.2 The Basics of Numpy Arrays
3.3 Computation on Numpy Arrays

Extra Reading/Key words*:* *Array reshaping, stacking, and splitting techniques, Random number generation, Broadcasting*

UNIT IV: Aggregation Values **(15 Hrs)**

4.1 Aggregations
4.2 Computation on Arrays - Comparisons
4.3 Introducing Pandas Objects - Aggregation and Grouping

Extra Reading/Key words*:* *Handling Missing value, Data filtering, sorting, and merging DataFrames*

UNIT V: Visualization With Matplotlib **(15 Hrs)**

5.1 General Matplotlib Tips – Simple line plots
5.2 Simple Scatter Plots – Density and Contour Plots
5.3 Customizing Plot Legends – Customizing Matplotlib
5.4 Three-Dimensional Plotting in Matplotlib – Visualization with seaborn

Extra Reading/Key words*: Subplots and Multiple Figure Layouts, Saving Figures in Different Formats (PNG, PDF, SVG), Adding Annotations, Interactive visualization using Plotly*

Note: Texts given in the Extra Reading/Keywords must be tested only through assignment and seminar.

PRESCRIBED TEXT BOOKS

1. Dr. R. Nageswara Rao. (2021). Core Python Programming (3th ed.). - Dreamlech Press .
   UNIT I: Chapter 1,3,4,5,6
   UNIT II: Chapter 8,10,11,12

2. Jake Vanderplas. (2022). Python Data Science Handbook (2th ed.). - Oreilly.
   UNIT III: Chapter 5,6,9
   UNIT IV: Chapter 7,8,9,13,20
   UNIT V: Chapter 25,26,27,28,29,34,35,36

SUGGESTED READINGS

1. 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.

WEB REFERENCES

1. https://realpython.comhttp://docs.python.org,
2. http://diveintopython.org/,
3. https://www.w3schools.com/python/
4. https://www.tutorialspoint.com/python/index.html

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K5)
CO 1	Identify the fundamental concepts of Python programming, including features, data types, operators, and control statements.	**K1**
CO 2	Explain the use of Python data structures and basic object-oriented programming concepts.	**K2**
CO 3	Apply Python programming and NumPy techniques to solve computational and numerical problems.	**K3**
CO 4	Analyze and manipulate datasets using NumPy arrays and Pandas operations such as aggregation, comparison, and grouping.	**K4**
CO 5	Evaluate and interpret data by creating and customizing visualizations using Matplotlib and Seaborn.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyse, K5=Evaluate

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	M	L	M	L	H	L	L	M	M
CO2	M	M	M	M	H	L	L	M	M
CO3	M	H	H	M	H	L	M	M	M
CO4	M	H	H	H	H	M	H	M	M
CO5	M	H	H	H	H	M	H	H	H

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO1	H	M	H
CO2	H	M	H
CO3	M	H	M
CO4	M	M	H
CO5	H	H	M

(For candidates admitted in the academic year 2026 - 2027)

Course Title	CORE COURSE 4: PYTHON PROGRAMMMING -LAB
Code	P26DS1CCP04
Course Type	Practical
Semester	I
Hours/Week	4
Total Hours	60
Credits	2
Marks	100

CONSPECTUS

To learn Python programs to meet routine and specialized data manipulation, management, analysis, and problem-solving tasks.

COURSE OBJECTIVES

1. To develop skills in basic programming and data analysis using Python.
2. To manipulate and manage data using Python data structures.
3. To visualize data using Python libraries and plotting tools.
4. To utilize Python functions, modules, and control structures for efficient coding.
5. To conduct basic computational and analytical tasks using Python and interpret results effectively.

EXERCISES

1. Develop programs to demonstrate basic Python constructs including data types, operators, input/output, and control statements.
2. Implement programs for string manipulation and operations on lists, tuples, sets, and dictionaries.
3. Design simple programs to illustrate basic object-oriented programming concepts using classes and objects.
4. Create and manipulate NumPy arrays including indexing, slicing, and reshaping operations.
5. Apply NumPy functions to perform numerical computations and statistical analysis.
6. Develop programs to perform array-based computations and comparisons using NumPy.
7. Create and manipulate Pandas Series and DataFrames for data handling.
8. Perform data aggregation, grouping, and filtering operations using Pandas.
9. Implement data preprocessing techniques including handling missing values and data transformation.
10. Develop visualizations using Matplotlib including line, bar, and scatter plots with appropriate customization.
11. Create advanced visualizations using Seaborn such as heatmaps and pair plots.
12. Analyze datasets and interpret results using appropriate visualization techniques.

COURSE OUTCOMES

The learners will be able to

CO. No.	Course Outcomes	CognitiveLevel (K1-K5)
CO 1	List the procedures required for installing the Python programming environment.	**K1**
CO 2	Utilize Python data types for developing programs.	**K2**
CO 3	Apply appropriate Python data structures on raw data.	**K3**
CO 4	Develop programming logic using Python modules and packages.	**K4**
CO 5	Analyze datasets using Python programming capabilities.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	L	L	M	L	H	L	L	M	M
CO 2	L	M	M	M	H	L	L	M	M
CO 3	M	H	H	M	H	L	M	M	M
CO 4	M	H	H	H	H	M	H	M	M
CO 5	M	H	H	H	H	M	H	H	H

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	M	M
CO 3	H	H	M
CO 4	H	H	H
CO 5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**ELECTIVE COURSE 1: R FOR DATA ANALYTICS**
Course Code	**P26DS1ECT01**
Course Type	**Theory**
Semester	**1**
Hours/Week	**4**
Total Hours	**60**
Credits	**3**
Marks	**100**

CONSPECTUS

To understand the concepts, tools, techniques, and methodologies involved in data analysis using R programming, including data visualization, data transformation, statistical analysis, and interpretation of results.

COURSE OBJECTIVES

1. To understand the fundamentals of R programming and data analysis
2. To explore data visualization and data transformation techniques using R
3. To analyze datasets using exploratory data analysis and statistical methods
4. To implement programming constructs and functions for efficient data processing in R
5. To develop data-driven solutions for real-world problems using R programming

UNIT I - Introduction to R & Visualization **(12 Hrs)**

1.1 Introduction to Data Science workflow
1.2 Basics of visualization
1.3 Grammar of graphics

Extra Reading /Keywords: *Data Science Lifecycle, Aesthetics Mapping*

UNIT II - Data Transformation **(12 Hrs)**

2.1. Data manipulation using dplyr
2.2. Filtering, selecting, arranging
2.3. Grouping and summarizing

Extra Reading /Keywords: *dplyr package, Data Wrangling, Data Aggregation*

UNIT III - Data Wrangling **(12 Hrs)**

3.1. Tidy data principles
3.2. Handling messy data
3.3. Data cleaning

Extra Reading /Keywords: *Missing Value Handling, Data Cleaning Techniques, Data Reshaping*

UNIT IV - Data Import **(12 Hrs)**

4.1. Importing CSV, Excel
4.2. Reading external data
4.3. Data preprocessing

Extra Reading /Keywords: *readr, readxl, Data Import Formats, APIs, Web Scraping Basics*

UNIT V: Programming In R **(12 Hrs)**

5.1. Functions
5.2. Iteration and control structures
5.3. Functional programming

Extra Reading /Keywords: *Functional Programming, Code Optimization*

Note: Texts given in the Extra Reading/Keywords must be tested only through assignment and seminar.

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K5)
CO 1	Recall and explain the basic concepts of R programming and data analysis	**K1**
CO 2	Identify and apply data structures and data manipulation techniques in R	**K2**
CO 3	Analyze datasets using exploratory data analysis and visualization techniques	**K3**
CO 4	Design and implement statistical models and functions using R programming	**K4**
CO 5	Create data-driven solutions for real-world problems using R and data analysis techniques	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyse, K5=Evaluate)

PRESCRIBED TEXT BOOK

1. Hadley Wickham, Mine Çetinkaya-Rundel, Garrett Grolemund, *"**R for Data Science** ", 2nd Edition*, O'Reilly, 2023
   UNIT I: Chapter 1, 2
   UNIT II: Chapter 3, 4
   UNIT III: Chapter 5, 6
   UNIT IV: Chapter 7, 8
   UNIT V: Chapter 9, 10

SUGGESTED READINGS

1. Robert I. Kabacoff, "R in Action: Data Analysis and Graphics with R" (3rd Edition), Manning Publications, 2022.
2. Kingsley Okoye, Samira Hosseini, "R Programming: Statistical Data Analysis in Research", Springer, 2024.
3. Rafael A. Irizarry, "Introduction to Data Science: Data Analysis and Prediction Algorithms with R" (2nd Edition), CRC Press, 2022.

WEB REFERENCES

1. https://www.geeksforgeeks.org/r-programming-language-introduction/
2. https://www.datacamp.com/tutorial/r-programming
3. https://www.coursera.org/learn/r-programming

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	M	L	M	L	H	L	L	M	M
CO 2	M	M	H	M	H	L	M	M	M
CO 3	M	H	H	H	H	M	H	M	M
CO 4	M	H	H	H	H	M	H	M	M
CO 5	M	H	H	H	H	M	H	H	H

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	H	M
CO 3	H	H	M
CO 4	H	H	H
CO 5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**ELECTIVE COURSE 1: INTERNET OF THINGS**
Code	**P26DS1ECT02**
Course Type	**Theory**
Semester	**I**
Hours/Week	**4**
Total Hours	**60**
Credits	**3**
Marks	**100**

CONSPECTUS

To understand the concepts, data, framework, standards, protocols, reliability, security and privacy involved in IOT

COURSE OBJECTIVES

1. To understand the fundamentals of internet of things
2. To realize the internet of things ecosystem using wireless technologies
3. To analyze various protocols for internet of things
4. To explore the design methodology of m2m communication in internet of things
5. To design a portable internet of things using raspberry pi and Arduino

UNIT I – Introduction to IOT **(12 Hrs)**

1.1 Definition, Characteristics and Physical Design of IoT
1.2 IoT Protocols and Communication Models
1.3 IoT Communication APIs and IoT Enabled Technologies (WSN, Cloud, Big Data, Embedded Systems)
1.4 IoT Levels, Templates and Domain Specific IoTs (Home, City, Health, Industry, etc.)

Extra Reading /Keywords*: Body area network, skin area network*

UNIT II - Realization of IOT Ecosystem Using Wireless Technologies **(12 Hrs)**

2.1 Mobile-based IoT Architecture and Technologies
2.2 Mobile Use Cases for IoT Applications
2.3 LPWAN Technologies – Sigfox, Weightless
2.4 LPWAN Technologies – Nwave, Ingenu

Extra Reading /Keywords: *Application Software-Android*

UNIT III - Infrastructure and Service Discovery Protocols for the IOT **(12 Hrs)**

1.1 IoT Layered Architecture and Protocol Architecture
1.2 Infrastructure Protocols for IoT
1.3 Device / Service Discovery Protocols
1.4 Security, Integration Technologies, Sensor & Actuator Networks

Extra Reading /Keywords: *OS-Contiki, Cooja*

UNIT IV - IOT and M2M **(12 Hrs)**

1.1 Introduction to M2M Communication
1.2 Differences between IoT and M2M
1.3 SDN and NFV for IoT
1.4 IoT Design Methodology

Extra Reading /Keywords: *Energy aware, Context aware*

UNIT V - Building IOT with Raspberry Pi and Arduino **(12 Hrs)**

5.1 IoT Systems and Logical Design using Python
5.2 Raspberry Pi: Hardware, Linux OS & Interfaces
5.3 Programming Raspberry Pi with Python
5.4 Other IoT Platforms: Arduino – Architecture, Devices & Integration

Extra Reading /Keywords: *Simulator - Proteus*

Note: Texts given in the Extra Reading/Keywords must be tested only through assignment and seminar.

PRESCRIBED TEXT BOOKS

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-On Approach", Universities Press (INDIA) Private Limited,2015.
   UNIT I: Chapters 1, 2.
   UNIT IV: Chapters 5
   UNIT V: Chapters 6
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things Enabling Technologies, Platforms, and Use Cases**"**, Taylor & Francis, CRC Press,2017.
   UNIT II: Chapter 3
   UNIT III: Chapter 4

SUGGESTED READINGS

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", First Edition, Academic Press,2014.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian(Eds), "Architecting the Internet of Things", Springer,2011.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things-key applications and Protocols",Wiley,2012.
4. Ovidiu Vermesan and Peter Friess, "Internet of Things –From Research Innovation to Market Deployment", RiverPublisher, 2014.

WEB REFERENCES

1. https://thingsee.com/blog/quality-hardware-list-for-your-iot-projects
2. https://tools.ietf.org/html/rfc7452.
3. http://dret.net/lectures/iot-
4. https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set
5. https://www.studocu.com/in/document/kalinga-institute-of-industrial-

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	CognitiveLevel (K1– K5)
CO 1	Recognize the basics of the Internet of Things.	**K1**
CO 2	Identify the application of wireless technologies in various domains.	**K2**
CO 3	Differentiate IoT from Machine-to-Machine(M2M) communication.	**K3**
CO 4	Design and demonstrate IoT applications using Python in Raspberry Pi.	**K4**
CO 5	Create a solution for real-time problems across various domains.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyse, K5=Evaluate)

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	H	M	L	L	M	M	L	L	L
CO 2	M	H	M	M	H	M	M	M	L
CO 3	M	H	H	M	H	M	M	M	M
CO 4	H	H	H	H	H	M	H	M	M
CO 5	H	H	H	H	H	H	H	H	M

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	H	M
CO 3	H	H	M
CO 4	H	H	H
CO 5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	**ELECTIVE COURSE 2 (DISCIPLINE SPECIFIC): R FOR DATA ANALYTICS -LAB**
Code	**P26DS1ECP03**
Course Type	**Practical**
Semester	**I**
Hours/Week	**4**
Total Hours	**60**
Credits	**2**
Marks	**100**

CONSPECTUS

To learn R programs to meet routine and specialized data manipulation, management and analysis.

COURSE OBJECTIVES

1. To develop skills in basic data analytics.
2. To manipulate and manage data using r's data structures
3. To visualize data with r's plotting capabilities
4. To utilize r functions and control structures for efficient coding.
5. To conduct statistical analysis and interpret results using r.

EXERCISES

1. Basic Data Manipulation.
2. Basic Plotting.
3. Loops and Functions.
4. Basic Statistics.
5. Advanced Data Manipulation.
6. Vector and operations on Vector.
7. Matrix and operations on Matrix.
8. Create factorization in R environment.
9. Data Frame and operations on Data Frame.
10. Write R Program to pre-defined functions in R.

COURSE OUTCOMES

The learners will be able to

CO. No.	Course Outcomes	CognitiveLevel (K1-K5)
CO 1	List the procedures required for installing the r Programming environment.	**K1**
CO 2	Utilize R data types for developing programs.	**K2**
CO 3	Apply appropriate r data structures on raw data.	**K3**
CO 4	Develop programming logic using r packages.	**K4**
CO 5	Analyze the datasets using r programming capabilities.	**K5**

(K1=Remember,K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

MAPPING

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	M	M	H	L	M	M	L	L	M
CO 2	M	H	H	M	H	M	L	M	M
CO 3	M	H	H	H	M	L	M	H	M
CO 4	H	H	H	M	H	M	L	M	L
CO 5	H	H	M	H	H	H	M	H	M

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	H	M
CO 3	M	H	M
CO 4	M	H	H
CO 5	H	H	H

(For candidates admitted in the academic year 2026 - 2027)

Course Title	ELECTIVE COURSE 2 (DISCIPLINE SPECIFIC): INTERNET OF THINGS - LAB
Code	P26DS1ECP04
Course Type	Practical
Semester	I
Hours/Week	4
Total Hours	60
Credits	2
Marks	100

CONSPECTUS

The course aims to provide hands-on experience in configuring IoT devices, integrating sensors and communication technologies, and developing real-time IoT applications using platforms like Arduino and Raspberry Pi.

COURSE OBJECTIVES

1. To recall the fundamental concepts of IoT architecture, components, sensors, actuators, and communication protocols.
2. To explain the role of microcontrollers, IoT platforms, and wireless technologies in building IoT systems.
3. To implement IoT applications using Arduino/Raspberry Pi with sensor data acquisition and device control.
4. To analyze real-time data transmission, storage, and visualization through IoT cloud platforms and dashboards.
5. To evaluate IoT solutions by testing performance, scalability, and applicability in real- world domains.

EXERCISES

1. Getting Started with Arduino/Raspberry Pi – Setting up the development environment, installing IDE, and running a simple "Blink LED" program.
2. Sensor Interfacing – Reading data from temperature and humidity sensors (e.g., DHT11/DHT22) and displaying it.
3. Actuator Control – Interfacing a servo motor or DC motor with Arduino/Raspberry Pi and controlling it through code.
4. Wireless Communication – Establishing communication between IoT devices using Bluetooth or Wi-Fi modules (e.g., ESP8266/ESP32).
5. Data Transmission to Cloud – Sending sensor data to IoT cloud platforms (e.g., ThingSpeak, Blynk, or AWS IoT).
6. Data Visualization – Creating real-time dashboards to monitor sensor readings (temperature, humidity, light, etc.).
7. Home Automation System – Controlling home appliances (light/fan) through IoT using a mobile app or web interface.
8. Environmental Monitoring – Building an IoT-based weather station to measure parameters such as temperature, humidity, and air quality.
9. Security Application – Implementing an IoT-based intrusion detection/alarm system using PIR motion sensors.
10. Smart Healthcare Application – Designing a simple IoT system for patient monitoring (e.g., heart rate or body temperature sensor).

COURSE OUTCOMES
The learners will be able to

CO. No.	Course Outcomes	CognitiveLevel (K1-K5)
CO 1	List the steps required for the installation and configuration of Arduino/Raspberry pi development environment	**K1**
CO 2	Utilize IoT components such as sensors and actuators for developing applications.	**K2**
CO 3	Make use of wireless communication protocols (Bluetooth, wi-fi, mqtt) in IoT systems.	**K3**
CO 4	Analyze real-time sensor data using iot cloud platforms and dashboards	**K4**
CO 5	Develop programming logic for iot devices using python/Arduino IDE.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

MAPPING
PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	M	M	M	L	M	M	L	L	M
CO 2	M	H	M	M	H	M	M	M	M
CO 3	H	H	H	M	H	M	M	M	L
CO 4	H	H	M	H	H	H	M	H	M
CO 5	H	H	H	H	H	H	H	H	H

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO 1	H	M	L
CO 2	H	M	M
CO 3	H	H	M
CO 4	M	H	H