University of Mumbai

No. AAMS_UGS/ICC/2023-24/27

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office Circular No. AAMS (UG)/107 of 2021-22 dated 08th October, 2021 relating to the revised syllabus as per the (CBCS) for the S.Y.B. Sc. Data Science (Sem -III & IV) & AAMS_UGS/ICD/2022-23/99 dated 15th September, 2022 relating to the B.Sc. (Data Science) (CBCS).

They are hereby informed that the recommendations made by the Board of Deans at its meeting held on 27th June, 2023 **vide** item No. 6.3 (R) have been accepted by the Academic Council at its meeting held on 27th June, 2023 **vide** item No. 6.3 (R) and that in accordance therewith, the **revised syllabus of T.Y.B. Sc. (Data Science) (CBCS) (Sem – V & VI)** has been brought into force with effect from the academic year 2023-24.

(The said circular is available on the University's website www.mu.ac.in).

(Prof. Sunil Bhirud)
I/c. REGISTRAR

MUMBAI – 400 032
13th July, 2023

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.3 (R) /27/06/2023

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies **Data Science**,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

Copy for information and necessary action :-

1. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
2. **College Teachers Approval Unit (CTA),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
5. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
6. **The Deputy Registrar, Executive Authorities Section (EA)**
   He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
7. **The Deputy Registrar, PRO, Fort, (Publication Section),**
8. **The Deputy Registrar, Special Cell,**
9. **The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
10. **The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

1. **The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
   He is requested to upload the Circular University Website
2. **The Director of Department of Student Development (DSD),**
3. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**
4. **All Deputy Registrar, Examination House,**
5. **The Deputy Registrars, Finance & Accounts Section,**
6. **The Assistant Registrar, Administrative sub-Campus Thane,**
7. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
8. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
9. **P.A to Hon'ble Vice-Chancellor,**
10. **P.A to Pro-Vice-Chancellor,**
11. **P.A to Registrar,**
12. **P.A to All Deans of all Faculties,**
13. **P.A to Finance & Account Officers, (F & A.O),**
14. **P.A to Director, Board of Examinations and Evaluation,**
15. **P.A to Director, Innovation, Incubation and Linkages,**
16. **P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
17. **The Receptionist,**
18. **The Telephone Operator,**

Copy with compliments for information to :-

19. **The Secretary, MUASA**
20. **The Secretary, BUCTU.**

AC – 27/06/2023
Item No. 6.3 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus for

T.Y.B.Sc. (Data Science)

(Sem. V & VI)

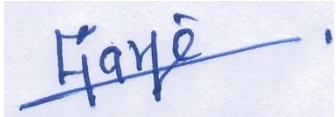
(CBCS)

(With effect from the academic year 2023 – 2024)

University of Mumbai

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**O: _____ Title of Course**	T.Y.B.Sc. (Data Science)
2	**O: _____ Eligibility**	Ordinance no. O.5051 Circular no. UG/284 of 2007 dated 16th June 2007, Natural Progression for Second Year B.Sc. Data Science
3	**R: _____ Passing Marks**	40%
4	No. of years/Semesters:	3 Years/ 6 Semesters
5	Level:	~~P.G.~~ / U.G./ ~~Diploma~~ / Certificate **(Strike out which is not applicable)**
6	Pattern:	~~Yearly~~ / Semester **(Strike out which is not applicable)**
7	Status:	Revised / ~~New~~ **(Strike out which is not applicable)**
8	To be implemented from Academic Year :	From Academic Year: 2023-24



Prof. Shivram S. Garje,
Dean,
Faculty of Science and Technology

SEMESTER 5				
Course Code	**Course Type**	**Course Name**	**Credits**	**Marks**
USDS501	**DSC**	Computer Vision	**2**	**100**
USDS5P1	**DSC**	Computer Vision Practical	**2**	**50**
USDS502	**DSC**	Data Engineering	**2**	**100**
USDS5P2	**DSC**	Data Engineering Practical	**2**	**50**
USDS503	**DSC**	Robotic Process Automation	**2**	**100**
USDS5P3	**DSC**	Robotic Process Automation Practical	**2**	**50**
USDS504	**SEC**	Campus to Corporate	**2**	**100**
USDS5P4	**DSC**	Project Dissertation	**2**	**50**
Elective 1 (Select Any one of the following)				
USDS505a	**DSE**	Social Media Analytics	**2**	**100**
USDS505b	**DSE**	Business Forecasting		
USDS505c	**DSE**	Marketing and Retail Analytics		
Compulsory Practical				
USDS5P5	**DSC**	Data Visualisation with Tableau	**2**	**50**
		Total	**20**	**750**

SEMESTER 6				
Course Code	**Course Type**	**Course Name**	**Credits**	**Marks**
USDS601	**DSC**	Machine Learning	**2**	**100**
USDS6P1	**DSC**	Machine Learning Practical	**2**	**50**
USDS602	**DSC**	Exploratory Data Analysis	**2**	**100**
USDS6P2	**DSC**	Exploratory Data Analysis Practical	**2**	**50**
USDS603	**SEC**	Internet of Things	**2**	**100**
USDS6P3	**SEC**	Internet of Things Practical	**2**	**50**
USDS604	**DSC**	Applied Business Analytics	**2**	**100**
USDS6P4	**DSC**	Applied Business Analytics Practical	**2**	**50**
Elective 2 (Select Any one of the following)				
USDS605a	**DSE**	Sports Analytics	**2**	**100**
USDS605b	**DSE**	Healthcare Analytics		
USDS605c	**DSE**	Data Governance		
Compulsory (Project Implementation)				
USDS6P5	**DSC**	Project Implementation	**2**	**50**
		Total	**20**	**750**

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Semester V

USDS501: Computer Vision

B. Sc (Data Science)		Semester – V	
Course Name: Computer Vision		**Course Code: USDS501**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
This course is an introduction to the field of Computer Vision (CV), Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand.
Computer vision works much the same as human vision, except humans have a head start. Human sight has the advantage of lifetimes of context to train how to tell objects apart, how far away they are, whether they are moving and whether there is something wrong in an image. Computer vision trains machines to perform these functions, but it has to do it in much less time with cameras, data and algorithms rather than retinas, optic nerves and a visual cortex. Because a system trained to inspect products or watch a production asset can analyze thousands of products or processes a minute, noticing imperceptible defects or issues, it can quickly surpass human capabilities.

Course Objectives:
- To introduce students the fundamentals of image formation.
- To introduce students the fundamentals of Image Processing.
- To introduce students the various features of Image
- To introduce students to the major ideas, methods, and techniques of computer vision and pattern recognition.
- To give knowledge to students about Applications of Computer Vision.

Unit	Details	Lectures
I	**Image Formation and Image Processing** : Introduction to Computer Vision and Basic Concepts of Image Formation, Introduction and Goals of Computer Vision, Image Formation and Radiometry, Geometric Transformation, Geometric Camera Models, Image Reconstruction from a Series of Projections	**12**
II	**Image Processing Concepts**: Fundamentals of Image Processing, Image Transforms, Image Filtering, Colour Image Processing, Mathematical Morphology, Image Segmentation	**12**
III	**Image Features** : Image Descriptors and Features, Texture Descriptors, Colour Features, Edge Detection, Object Boundary and	**12**

	Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Speeded up Robust Features, Saliency	
IV	**Recognition:** Fundamental Pattern Recognition Concepts, Introduction to Pattern Recognition, Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Gaussian Classier, Parameter Estimation, Clustering for Knowledge Representation, Dimension Reduction, Template Matching, Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Autoencoder	**12**
V	**Applications of Computer Vision:** Machine Learning Algorithms and their Applications in Medical, Image Segmentation, Motion Estimation and Object Tracking, Face and Facial Expression Recognition, Gesture Recognition, Image Fusion, Programming Examples	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Computer Vision and Image Processing	Manas Kamal Bhuyan	CRC Press	1st	2020
2.	Computer Vision: A Modern Approach	David A. Forsyth, Jean Ponce	Pearson	2nd	2012
3.	Machine Vision	R. Jain, R. Kasturi, and B. G. Schunk	McGraw-Hill	1st	1995
4.	Image Processing, Analysis, and Machine Vision	Milan Sonka,Vaclav Hlavac, Roger Boyle	Thomson Learning	3rd	2007
5.	Computer and Robot Vision	Robert Haralick and Linda Shapiro	Addison-Wesley	1st	1993

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand the fundamentals of image formation.
- Use and Demonstrate operations of Image Processing.
- Relate and Explain various features of Image.
- Understand, Identify and Examine various image patterns.
- Design and develop practical and innovative image processing and computer vision applications or systems.

USDS5P1: Computer Vision Practical

B. Sc (Data Science)		Semester – V	
Course Name: Computer Vision Practical		**Course Code: USDS5P1**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Objectives:

- To understand and use the Image features.
- To learn Histogram operations.
- To learn Image Filtering.
- To learn and understand Image colours.
- To understand image filtering techniques.

Sr.	List of Practical
1	**Basic operation on Image**
A	Program to change the Brightness of Image.
B	To Flip the image around the vertical and horizontal line.
C	Display the color components of the image.
D	Display of gray scale images.
E	To find the negative of an image.
2	**Using histogram for image quality analysis**
A	Calculate the Histogram of a given image.
B	Histogram Equalization.
3	Program for Image Filtering
A	Low pass filter => 1)Average filter2)Weighted Average filter3)Median filter High pass filters using=>1) Sobel operator2) Laplacian operator
B	Design non-linear filtering.
4	Edge detection with gradient and convolution of an Image
5	Finding Threshold of Images
A	Program to find threshold of grayscale image.
B	Program to find threshold of RGB image.
6	Program to estimate and subtract the background of an image.
7	Program to convert color image to gray and hsv.
8	
A	Determination of edge detection using operators.
B	2-D DFT and DCT.
C	Filtering in Frequency domain.
9	
A	Display of colour images.
B	Conversion between colour spaces.

10	
A	DWT of images
B	Segmentation using watershed transform

Course Outcomes:
Upon the successful completion of this course, students will be able to:

- Identify various Image features.
- Experiment with Histogram operations.
- Apply Image Filtering.
- Understand and make use of Image colours.
- Apply and make use of image filtering techniques.

USDS502: Data Engineering

B. Sc. (Data Science)		**Semester – V**	
Course Name: Data Engineering		**Course Code: USDS502**	
Periods per week (1 Period is 50 minutes)		**5**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
Data engineering refers to the building of systems to enable the collection and usage of data. This data is usually used to enable subsequent analysis and data science; which often involves machine learning. Making the data usable usually involves substantial compute and storage, as well as data processing and cleaning.

Course Objectives:
- To know the Data Engineering basics and Lifecycle.
- To understand the Data Architecture Design with various options available.
- To learn the Data generation and Storage.
- To understand Ingestion process and know about Queries, Modeling, and Transformation.
- To learn Data Analytics, Machine Learning and to know the importance of Security and Privacy.

Unit	Details	Lectures
I	**Foundation and Building Blocks**: Data Engineering Described, What Is Data Engineering? Data Engineering Skills and Activities, Data Engineers Inside an Organization, **The Data Engineering Lifecycle**: What Is the Data Engineering Lifecycle? Major Undercurrents Across the Data Engineering Lifecycle	**12**
II	**Designing Good Data Architecture**: What Is Data Architecture? Principles of Good Data Architecture, Major Architecture Concepts, Examples and Types of Data Architecture, Who's Involved with	**12**

	Designing a Data Architecture? **Choosing Technologies Across the Data Engineering Lifecycle:** Team Size and Capabilities, Speed to Market, Interoperability, Cost Optimization and Business Value, Today Versus the Future: Immutable Versus Transitory Technologies, Location, Build Versus Buy, Monolith Versus Modular, Serverless Versus Servers, Optimization, Performance, and the Benchmark Wars, Undercurrents and Their Impacts on Choosing Technologies	
III	**Data Generation in Source Systems**: Sources of Data: How Is Data Created? Source Systems: Main Ideas, Source System Practical Details, Whom You'll Work With, Undercurrents and Their Impact on Source Systems **Storage**: Raw Ingredients of Data Storage, Data Storage Systems, Data Engineering Storage Abstractions, Big Ideas and Trends in Storage, Whom You'll Work With, Undercurrents	**12**
IV	**Ingestion**: What Is Data Ingestion? Key Engineering Considerations for the Ingestion Phase, Batch Ingestion Considerations, Message and Stream Ingestion Considerations, Ways to Ingest Data, Whom You'll Work With, Undercurrents **Queries, Modelling, and Transformation**: Queries, Data Modelling, Transformations, Whom You'll Work With, Undercurrents	**12**
V	**Serving Data for Analytics, Machine Learning, and Reverse ETL**: General Considerations for Serving Data, Analytics, Machine Learning, What a Data Engineer Should Know About ML, Ways to Serve Data for Analytics and ML, Reverse ETL, Whom You'll Work With, Undercurrents **Security and Privacy**: People, Processes, Technology **The Future of Data Engineering**: The Decline of Complexity and the Rise of Easy-to-Use Data Tools, The Cloud-Scale Data OS and Improved Interoperability, "Enterprisey" Data Engineering, Titles and Responsibilities Will Morph, Moving Beyond the Modern Data Stack, Toward the Live Data Stack **Serialization and Compression Technical Details**: Serialization Formats, Columnar Serialization, Hybrid Serialization, Database Storage Engines, Compression: gzip, bzip2, Snappy, Etc, **Cloud Networking**: Cloud Network Topology, Data Egress Charges, Availability Zones, Regions, GCP-Specific Networking and Multiregional Redundancy, Direct Network Connections to the Clouds, CDNs, The Future of Data Egress Fees	**12**

Books and References:					
Sr.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Fundamentals of Data Engineering	Joe Reis and Matt Housley	O'Reilly Media	1st	2022
2.	Learning Spark: Lightning-Fast Data Analytics	Jules S. Damji, Brooke Wenig	O'Reilly Media	2nd	2020
3.	Kafka: The Definitive Guide: Real-Time Data and Stream Processing at Scale	Neha Narkhede, Gwen Shapira & Todd Palino	O'Reilly Media	1st	2017
4.	Data Pipelines Pocket Reference	James Densmore	O'Reilly Media	1st	2021
5.	Data Engineering with Python	Paul Crickard	Packt Publishing	1st	2020

Course Outcomes:
After completion of the course, a student should be able to:

- To remember and explain the Data Engineering basics and Lifecycle.
- To apply the Data Architecture Design with various options available.
- To create the Data from source and make use of Storage.
- To understand Ingestion process and know about Queries, Modeling, and Transformation.
- To Illustrate Data Analytics, Machine Learning and to Explain the importance of Security and Privacy.

USDS5P2: Data Engineering Practical

B. Sc (Data Science)		**Semester – V**	
Course Name: Data Engineering Practical		**Course Code: USDS5P2**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Objectives:
- To know the working of Resilient Distributed Dataset.
- To understand the structure and working of Dataframe.
- To know use of Array and Map Operations.
- To understand Spark SQL Joins, Schema, StructType & Functions.
- To learn Spark Data Source API, Streaming.

List of Practical

Sr	Practical Details
1	**Practicals on RDD (Resilient Distributed Dataset) with Scala Operations and transformations.**
a)	**Use of next mentioned operations and functions:** Parallelize, Read text file, Read CSV, Create RDD, Actions, Pair Functions, Repartition and Coalesce, Shuffle Partitions, Broadcast Variables, Accumulator Variables and Convert RDD to DataFrame
b)	**Use of next mentioned operations** : Read multiple text files into RDD, Read CSV file into RDD, Create an empty RDD, RDD Pair Functions and Generate DataFrame from RDD
2	**Practical on the DataFrame operations**
a)	**Demonstrate the use of next mentioned operations:** Create an empty DataFrame, Create an empty DataSet, use of Rename nested column, Adding or Updating a column on DataFrame, Drop a column on DataFrame, Adding literal constant to DataFrame, Changing column data type, Pivot and Unpivot a DataFrame, Create a DataFrame using StructType & StructField schema
b)	**Use of next mentioned operations:** Selecting the first row of each group, Sort DataFrame, Union DataFrame, Drop Rows with null values from DataFrame, Split single to multiple columns, Concatenate multiple columns, Replace null values in DataFrame, Remove duplicate rows on DataFrame, Remove distinct on multiple selected columns, Spark UDF
3	**Practical on the Spark Array and Map operations**
a)	**Use of next mentioned operations:** Create an Array (ArrayType) column on DataFrame, Create a Map (MapType) column on DataFrame, Convert an Array to columns, Create an Array of struct column, Explode an Array and map columns, Explode an Array of structs, Explode an Array of map columns to rows
b)	**Use of next mentioned operations:** Create a DataFrame with nested Array, Explode nested Arrays to rows, Flatten nested Array to single Array, Convert array of String to a String column
4	**Spark Aggregate :** Group rows in DataFrame, Get Count distinct on DataFrame, Add row number to DataFrame, Select the first row of each group
5	**Spark SQL Joins, Spark SQL Schema, StructType & SQL Functions**
a)	**Use of next mentioned operations:** Use of Spark SQL Join, Join multiple DataFrames, Inner join two tables/DataFrame, Self join, Join tables on multiple columns, Convert case class to a schema, Create array of struct column, Flatten nested column
b)	**Use of next mentioned functions** : Date and Time Functions, String Functions, Array Functions, Map Functions, Aggregate Functions, Window Functions, Sort Functions, JSON Functions
6	**Spark SQL :** Demonstrate the use of next functions : createDataFrame(), where() & filter(), withColumn(), withColumnRenamed(), drop(), distinct(), groupBy(), join(), map() vs mapPartitions(), foreach() vs foreachPartition(), pivot(), union(), collect(), cache() & persist(), udf()
7	**Spark Data Source API**
a)	**Use of next operations :**Process JSON from a Text file, Read & Write CSV file, Read and Write JSON file, Read & Write Parquet file, Read & Write XML file, Read & Write Avro files

b)	**Use of next operations :** Read & Write HBase using "hbase-spark" Connector, Read & Write from HBase using Hortonworks, Read & Write ORC file, Read Binary File
c)	**Use of File conversions operations from each type to other :** CSV**,** Parquet, JSON, Avro, Text file
8	**Practical of Spark Streaming**
a)	**Use of next operations :** OutputModes Append vs Complete vs Update, Read JSON Files From Directory with Scala Example, Read data From TCP Socket with Scala Example, Consuming & Producing Kafka messages in JSON format
b)	**Use of next operations :**Consuming & Producing Kafka messages in Avro format, from_avro and to_avro functions, Avro data from Kafka topic using from_avro() and to_avro(), Batch Processing using Kafka Data Source
9	**Spark MLlib : Demonstrate use of Estimator, Transformer, and Param**
10	**Spark HDFS : Demonstrate the use of next operations :**Processing files from Hadoop HDFS (TEXT, CSV, Parquet, Avro, JSON), Processing TEXT files from Amazon S3 bucket, Processing JSON files from Amazon S3 bucket, Processing CSV files from Amazon S3 bucket, Processing Parquet files from Amazon S3 bucket, Processing Avro files from Amazon S3 bucket

Course Outcome:

Upon the successful completion of this course, students will be able to:

- To apply and build the working of Resilient Distributed Dataset.
- To analyse and evaluate working of Dataframe.
- To perform and use Array and Map Operations.
- To apply and experiment with Spark SQL Joins, Schema, StructType & Functions.
- To effective use Spark Data Source API, Streaming.

USDS505c: Robotic Process Automation

B. Sc (Data Science)		**Semester – V**	
Course Name: Robotic Process Automation		**Course Code: USDS505c**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:

Robotic process automation (RPA) is a form of business process automation technology based on metaphorical software robots (bots) or on artificial intelligence (AI)/digital workers. It is sometimes referred to as software robotics (not to be confused with robot software).

In traditional workflow automation tools, a software developer produces a list of actions to automate a task and interface to the back-end system using internal application programming interfaces (APIs) or dedicated scripting language. In contrast, RPA systems develop the action

list by watching the user perform that task in the application's graphical user interface (GUI), and then perform the automation by repeating those tasks directly in the GUI. This can lower the barrier to the use of automation in products that might not otherwise feature APIs for this purpose.

Course Objectives:

- To make the students aware about the automation today in the industry.
- To make the students aware about the tools used for automation.
- To help the students automate a complete process

Unit	Details	Lectures
I	**Robotic Process Automation:** Scope and techniques of automation, About UiPath **Record and Play:** UiPath stack, Downloading and installing UiPath Studio, Learning UiPath Studio, Task recorder, Step-by-step examples using the recorder.	**12**
II	**Sequence, Flowchart, and Control Flow:** Sequencing the workflow, Activities, Control flow, various types of loops, and decision making, Step-by-step example using Sequence and Flowchart, Step-by-step example using Sequence and Control flow **Data Manipulation**: Variables and scope, Collections, Arguments – Purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example, CSV/Excel to data table and vice versa (with a step-by-step example)	**12**
III	**Taking Control of the Controls** : Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Working with UiExplorer, Handling events, Revisit recorder, Screen Scraping, When to use OCR, Types of OCR available, How to use OCR, Avoiding typical failure points **Tame that Application with Plugins and Extensions**: Terminal plugin, SAP automation, Java plugin, Citrix automation, Mail plugin, PDF plugin, Web integration, Excel and Word plugins, Credential management, Extensions – Java, Chrome, Firefox, and Silverlight	**12**
IV	**Handling User Events and Assistant Bots**: What are assistant bots?, Monitoring system event triggers, Hotkey trigger, Mouse trigger, System trigger ,Monitoring image and element triggers, An example of monitoring email, Example of monitoring a copying event and blocking it, Launching an assistant bot on a keyboard event **Exception Handling, Debugging, and Logging**: Exception handling, Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting	**12**

V	**Managing and Maintaining the Code**: Project organization, Nesting workflows, Reusability of workflows, Commenting techniques, State Machine, When to use Flowcharts, State Machines, or Sequences, Using config files and examples of a config file, Integrating a TFS server **Deploying and Maintaining the Bot**: Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots, License management, Publishing and managing updates	**12**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Learning Robotic Process Automation	Alok Mani Tripathi	Packt	1st	2018
2.	Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation	Srikanth Merianda	Createspace Independent Publishing	1st	2018
3.	The Simple Implementation Guide to Robotic Process Automation (Rpa): How to Best Implement Rpa in an Organization	Kelly Wibbenmeyer	iUniverse	1st	2018

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand and implement the mechanism of business process and can provide the solution in an optimize way.
- Apply the features use for interacting with database plugins.
- Apply and Use the plug-ins and other controls used for process automation.
- Implement and handle the different events, debugging and managing the errors.
- Test and deploy the automated process.

USDS5P3: Robotic Process Automation Practical

B. Sc (Data Science)		Semester – V	
Course Name: Robotic Process Automation Practical		**Course Code: USDS5P3**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Objectives:

1. UiPath Fundamentals: The course aims to provide a solid foundation in UiPath RPA software. Students will learn about the UiPath platform, its components, and key features. They will gain a thorough understanding of UiPath Studio, Orchestrator, and other UiPath tools necessary for building and managing software robots.

2. Workflow Design and Development: The primary objective is to equip students with the skills needed to design and develop automation workflows using UiPath Studio. Students will learn how to use the drag-and-drop interface, activities, variables, and conditions to create efficient and robust automation solutions.

3. Data Manipulation and Integration: The course focuses on teaching students how to work with data in UiPath. They will learn how to extract data from various sources, manipulate and transform it using UiPath activities, and integrate it with other systems or applications.

4. Exception Handling and Error Management: Error handling is a critical aspect of RPA development. Students will learn techniques for identifying and handling exceptions that may occur during automation execution. They will also understand how to implement error logging and notifications to ensure smooth and reliable automation processes.

5. Orchestrator Configuration and Management: UiPath Orchestrator is a central component for managing and monitoring software robots. The course aims to teach students how to configure and manage Orchestrator, including creating and scheduling jobs, managing assets and queues, and monitoring automation performance.

6. Advanced UiPath Features: The course covers advanced features and capabilities of UiPath. It includes topics such as screen scraping, OCR (Optical Character Recognition), Citrix automation, web automation, and working with APIs. Students will gain exposure to a wide range of UiPath functionalities to handle complex automation scenarios.

Practical 1: RPA Basics: Sequences and Flowcharts	
a.	Create a simple sequence-based project.
b.	Create a flowchart-based project.
c.	Automate UiPath Number Calculation (Subtraction, Multiplication, Division of numbers).
d.	Create an automation UiPath project using different types of variables (number, datetime, Boolean, generic, array, data table)

Practical 2: Decision making and looping	
a.	Consider an array of names. We have to find out how many of them start with the letter "a". Create an automation where the number of names starting with "a" is. counted and the result is displayed.
b.	Demonstrate switch statement with an example.
c.	Create an automation To Print numbers from 1 to 10 with break after the writeline activity inside for each activity
d.	Create an automation using Do..While Activity to print numbers from 5 to 1
e.	Create an automation using Delay Activity between two writeline activities to separate their execution by 5 seconds
f.	Create an automation to demonstrate use of decision statements (if)
Practical 3: Types of Recording	
a.	Basic Recording using Toolbar
b.	Basic Recording using Notepad
c.	Desktop Recording using Tool bar
d.	Desktop Recording by creating a workflow
e.	Web Recording e.g. Find the rating of the movie from imdb web site
f.	Web Recording manually
Practical 4: Excel Automation	
a.	Automate the process to extract data from an excel file into a data table and vice versa
b.	Create an automation To Write data to specific cell of an excel sheet.
c.	Create an automation To Read data to specific cell of an excel sheet.
d.	Create an automation To append data to specific cell of an excel sheet.
e.	Create an automation To sort a table of an excel sheet.
f.	Create an automation To filter a table of an excel sheet
Practical 5: Different controls in UiPath	
a.	Implement the attach window activity.
b.	Automate using Anchor Base.
c.	Automate using Element Exists.
d.	Automate using Find Children control.
e.	Use Get Ancestor control
f.	Use Find Relative control
Practical 6: Keyboard and Mouse Events	
a.	Demonstrate the following activities in UiPath: i. Mouse (click, double click and hover) ii. Type into iii. Type Secure text
b.	Demonstrate the following events in UiPath: i. Element triggering event ii. Image triggering event iii. System Triggering Event
c.	Automate the process of launching an assistant bot on a keyboard event.
Practical 7: Screen Scraping and Web Scraping methods	
a.	Automate the following screen scraping methods using UiPath: i) Full Text

b.	ii) Native
c.	iii) OCR
d.	Demonstrate Data Scraping and display values in Message box.
e.	Demonstrate Screen Scraping for a pdf, web page and image file.
Practical 8: PDF Automation and Exception Handling	
a.	Read PDF With OCR
b.	Merge PDF's into one
c.	Get PDF Total Page count Using Regex
d.	Demonstrate Exception Handling using UiPath
Practical 9: Email Automation	
a.	Configure Email using UiPath
b.	Read Emails
c.	Send Email with Attachment
d.	Save Email Attachments
e.	Reply to Email
Practical 10: Orchestrator management and mini project	
a.	Deploy bots to Orchestrator
b.	Run jobs from Orchestrator
c.	Queue Introduction: i. Add items to Queue. ii. Get Queue item from Orchestrator
d.	Build UiPath Chatbot using Google dialogflow

Course Outcomes:

Upon the successful completion of this course, students will be able to:

1. Recall and describe the fundamental concepts of RPA and UiPath. Memorize key features and functionalities of UiPath Studio and Orchestrator.
2. Explain the principles and mechanisms of RPA and how UiPath enables process automation.
3. Interpret the components and tools within the UiPath ecosystem and their respective roles.
4. Summarize the data manipulation and integration capabilities of UiPath.
5. Utilize UiPath Studio to create automation workflows and sequences for simple business processes.
6. Apply data extraction and manipulation techniques using UiPath activities.
7. Implement exception handling mechanisms to manage errors during automation execution.
8. Analyze and evaluate existing business processes to identify potential automation opportunities. Assess the suitability of different UiPath features and functionalities for specific automation scenarios.
9. Evaluate the efficiency and effectiveness of automation workflows and propose improvements.
10. Evaluate the performance and reliability of automated processes developed using UiPath.
11. Critically assess the suitability of UiPath Orchestrator for managing and monitoring automation.
12. Analyze the impact of RPA implementation on business processes and make recommendations for optimization.
13. Design and develop complex automation workflows using UiPath Studio, incorporating advanced functionalities such as screen scraping, OCR, and API integration.
14. Create comprehensive automation solutions that integrate multiple systems and applications using UiPath.

USDS504: Campus to Corporate

B. Sc (Data Science)		Semester – V	
Course Name: Cloud Computing		**Course Code: USDS504**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
The "Campus to Corporate" course is designed to equip students with the necessary communication and interpersonal skills required to transition successfully from a campus environment to a professional corporate setting. The course covers various aspects of communication, including active listening, effective speaking, interviews, business communication, negative news and crisis communication, intercultural and international business communication, group communication, teamwork, leadership, data interpretation, and logical reasoning. Students will develop a comprehensive understanding of these topics through theoretical discussions, practical exercises, and real-world case studies.

Course Objectives:
1. Develop active listening skills and understand the importance of empathy in communication.
2. Enhance speaking skills for confident and clear communication.
3. Gain knowledge about different types of interviews and improve interview performance.
4. Understand intrapersonal and interpersonal communication dynamics and conflict management in the workplace.
5. Learn effective strategies for delivering negative news and crisis communication.

Unit	Details	Lectures
I	**Active Listening:** Meaning and Art of Listening, Importance of Listening and Empathy in Communication, Reasons for Poor Listening, Poor Listening Habits, Traits of a Good Listener, Listening Modes and Types, Barriers to Effective Listening, Listening for General Content and Specific Information **Effective Speaking:** Basic Sounds of English, Word Stress, Sentence Stress, Intonation, Achieving Confidence, Clarity, and Fluency, Vocal Cues **Interviews:** Objectives of Interviews, Types of Interviews, Job Interviews, Résumés, Media Interviews, Press Conferences	**12**
II	**Intrapersonal and Interpersonal Business Communication:** Intrapersonal Communication, Self-Concept and Dimensions of Self, Interpersonal Needs, Social Penetration Theory, Rituals of Conversation and Interviews, Conflict in the Work Environment **Negative News and Crisis Communication:** Delivering a Negative News Message, Eliciting Negative News, Crisis Communication Plan, Press Conferences	**12**

III	**Intercultural and International Business Communication:** Intercultural Communication: How to Understand Intercultural Communication, Common Cultural Characteristics, Divergent Cultural Characteristics, **International Communication:** The Global Marketplace, Styles of Management, The International Assignment	**12**
IV	**Group Communication:** Use of Body Language in Group, Discussions, Group Discussions, Organizational GD, GD as Part of Selection Process, Meetings, Conferences **Group Communication, Teamwork, and Leadership:** Group Life Cycles and Member Roles, Group Problem Solving, Business and Professional Meetings, Teamwork and Leadership	**12**
V	**Data Interpretation:** Tabulation, Bar Graphs, Pie Chart, Line Graphs **Logical Reasoning:** Argument forms, structure of categorical propositions, Mood and Figure, Formal and Informal fallacies, Uses of language, Connotations and denotations of terms, Classical square of opposition, deductive and inductive reasoning, Analogies, Venn diagram	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Business Communication for Success	University of Minnesota	University of Minnesota		2015
2.	Technical Communication: Principles and Practice	Meenakshi Raman	Oxford University Press	3rd Edition	2015

Course Outcome:

Upon the successful completion of this course, students will be able to:

1. Apply active listening techniques and overcome barriers to become a better listener.
2. Demonstrate improved speaking skills with clarity, confidence, and fluency.
3. Utilize interview techniques to enhance job interview performance and create impactful résumés.
4. Apply interpersonal communication skills to build effective relationships and manage conflicts in professional settings.
5. Effectively deliver negative news messages, develop crisis communication plans, and handle press conferences in challenging situations.

USDS5P4: Project Dissertation and Implementation – 1

B. Sc (Data Science)		Semester – V	
Course Name: Project Dissertation and Implementation – 1		**Course Code: USDS5P4**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Description:

The Project Dissertation course in B.Sc Data Science allows students to independently undertake a research project in the field of data science. Through this course, students will apply their knowledge and skills to identify, plan, execute, and document a research study. They will address a real-world data science problem, demonstrating critical thinking, research competence, and effective communication skills. The course culminates in the submission of a comprehensive project dissertation, showcasing students' ability to conduct meaningful research in the field of data science.

Course Objectives:

1. To provide students with an opportunity to apply the knowledge and skills acquired throughout the B.Sc Data Science program in a real-world project.
2. To enable students to independently plan, design, and execute a research project in the field of data science.
3. To develop students' critical thinking and problem-solving abilities through the identification and analysis of complex data science problems.
4. To enhance students' research and project management skills, including data collection, data analysis, and result interpretation.
5. To foster effective communication and presentation skills by requiring students to document and present their research findings in a comprehensive project dissertation.

The project report should contain the following:

Table of Contents

- What is Data Science Project Report?
- 6 Fundamental Steps to Create a Data Science Report
    - Define the Data Science Project Topic and Problem Statement
    - Explain How You Intend to Address the Problem
    - Describe the Dataset and its Attributes
    - Outline the Design of Your Data Science Project
    - Conduct an In-depth Project Analysis
    - Wrap Up Your Project
- How to Write a Detailed Project Report on Data Science?
    - Defining the Data Science Problem Statement
    - Discuss Your Approach to Address the Problem Statement
    - Explain the Dataset and its Attributes

    - Define the Project Structure/Layout
    - Analyze the Steps in Detail
    - Summarize the Project Outcomes and Add References
- 10 Main Components of a Data Science Project Report
    - Project Title/Topic
    - Table of Contents
    - Abstract or Project Summary
    - Introduction
    - Dataset Description
    - Methods and Algorithms
    - Project Analysis
    - Final Results
    - Conclusion and Future Scope
    - References
    - Best Practices for A Data Science Project Report
    - Define the Objective of The Project Report
    - Focus More on the Outcomes, Not the Report
    - Develop a Thorough Project Strategy in Advance
    - Document Everything- Data, Design, Algorithms

Course Outcome:

Upon the successful completion of this course, students will be able to:

1. Students will demonstrate the ability to identify and formulate a research problem in the field of data science and define clear objectives and research questions.
2. Students will independently plan and execute a research project, including selecting appropriate research methodologies and data collection techniques.
3. Students will analyze and interpret data using advanced data analysis techniques, demonstrating proficiency in statistical analysis, machine learning, or other relevant methodologies.
4. Students will present their research findings in a well-structured, comprehensive project dissertation, adhering to academic writing standards and providing appropriate references.
5. Students will effectively communicate their research findings through oral presentations, demonstrating clear and concise delivery of information and responding to questions and feedback from peers and evaluators.

USDS505a: Social Media Analytics

B. Sc (Data Science)		Semester – V	
Course Name: Social Media Analytics		**Course Code: USDS505a**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:

This course on Social Media Analytics provides an in-depth exploration of key concepts, tools, and techniques for leveraging social media data. Students will learn about social media intelligence, monitoring metrics, customer profiling, social network analysis, text analytics, and recommender systems. The course emphasizes hands-on learning to develop practical skills in extracting insights from social media data and making data-driven decisions. By the end of the course, students will be equipped to navigate the complex landscape of social media analytics and apply these insights in real-world scenarios.

Course Objectives:

- Understand the fundamentals of social media analytics and its relevance in today's digital landscape.
- Learn different types of social media analytics and their applications, including customer profiling, location analytics, action analytics, mobile/app analytics, and Google Analytics.
- Gain knowledge of social network analysis, including network structure, egocentric networks, network metrics, and clustering techniques.
- Explore text analytics techniques used in social media, including data types, deployment models, and text mining algorithms.
- Develop practical skills in building recommender systems in social media using techniques such as association rule mining, collaborative filtering, and similarity measures

Unit	Details	Lectures
I	**Introduction to Social Media** Social Media Data, Social Media Intelligence & Listening, Social Media Monitoring Metrics, Types of Social Media tools, Theories in Media Research, Long Tail, electronic word-of-mouth (eWOM), Power Law& Popularity.	**12**
II	**Types of Social Media Analytics,** Knowing your customers –Seven layer Approach, Location Analytics, Action Analytics, Mobile/App Analytics, Google Analytics .	**12**
III	**Social Network Analysis** Introduction to Networks, Common network terms, Network structure, Types of Networks, Egocentric Networks, Network analysis metrics, Strong and Weak Ties, Clustering and Grouping.	**12**

IV	**Text Analytics in Social Media** Text Analytics data types, Deployment models, Purpose of text analytics, Text analytics value creation cycle, Text Mining algorithms**.**	**12**
V	**Recommender Systems in Social Media** Overview – Association rule mining – Collaborative filtering – User-based similarity – Item-based similarity Hands-on: Recommender System.	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	"Networks, Crowds, and Markets: Reasoning about a Highly Connected World"	David Easley and Jon Kleinberg	Cambridge University Press 3rd Edition	3rd Edition	2017
2.	"Analysing Social Media Networks with Node XL"	"Derek Hansen Ben Shneiderman Marc Smith ItaiHimelboim, Morgan Kaufmann		2nd Edition	2019
3.	"Social Media Mining: An Introduction"	Huan Liu, Mohammad Ali Abbasi, and Reza Zafarani	Cambridge University Press.	1st Edition	2014

Course Outcome:

Upon the successful completion of this course, students will be able to:

- Demonstrate a comprehensive understanding of social media analytics concepts, theories, and tools.
- Apply various social media analytics techniques to extract insights and make informed decisions.
- Perform social network analysis to uncover patterns, relationships, and influential nodes within social networks.
- Utilize text analytics methods to extract meaningful information from social media text data.
- Design and implement recommender systems for social media platforms, considering user preferences and item similarities to enhance user experiences.

USDS505b: Business Forecasting

B. Sc (Data Science)		Semester – V	
Course Name: Business Forecasting		**Course Code: USDS505b**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
Business forecasting refers to the tools and techniques used to predict developments in business, such as sales, expenditures, and profits. The purpose of business forecasting is to develop better strategies based on these informed predictions. Past data is collected and analysed via quantitative or qualitative models so that patterns can be identified and can direct demand planning, financial operations, future production, and marketing operations.
The use of forecasts in business management is indispensable for nearly every decision in every industry. The use of business forecasting provides information that helps business managers identify and understand weaknesses in their planning, adapt to changing circumstances, and achieve effective control of business operations.

Course Objectives:

- Students will have a command of business theory and practice in the field of business forecasting.
- To learn different forecasting models/techniques both quantitative and qualitative.
- Students will use reasoned and ethical judgment when analyzing problems and making decisions.
- Students will be able to understand complex business situations and provide solutions to improve current business practices.
- Students will be effective communicators.

Unit	Details	Lectures
I	**Fundamental Considerations in Business Forecasting** : Getting Real about Uncertainty, What Demand Planners Can Learn from the Stock Market, Toward a More Precise Definition of Forecastability, Forecastablity: A New Method for Benchmarking and Driving Improvement, Forecast Errors and Their Avoidability, The Perils of Benchmarking, Can We Obtain Valid Benchmarks from Published Surveys of Forecast Accuracy? Defining "Demand" for Demand Forecasting, Using Forecasting to Steer the Business: Six Principles, The Beauty of Forecasting **Methods of Statistical Forecasting** : Confessions of a Pragmatic Forecaster, New Evidence on the Value of Combining Forecasts, How to Forecast Data Containing Outliers, Selecting Your Statistical Forecasting Level, When Is a Flat-line Forecast Appropriate? Forecasting by Time Compression, Data Mining for Forecasting: An Introduction, Process and Methods for Data Mining for Forecasting, Worst-Case Scenarios in Forecasting: How Bad Can Things Get? Good	**12**

	Patterns, Bad Patterns	
II	**Forecasting Performance Evaluation and Reporting:** Dos and Don'ts of Forecast Accuracy Measurement: A Tutorial, How to Track Forecast Accuracy to Guide Forecast Process Improvement, A "Softer" Approach to the Measurement of Forecast Accuracy, Measuring Forecast Accuracy, Should We Define Forecast Error as e = F – A or e = A – F? Percentage Error: What Denominator? Percentage Errors Can Ruin Your Day, Another Look at Forecast-Accuracy Metrics for Intermittent Demand, Advantages of the MAD/Mean Ratio over the MAPE, Use Scaled Errors Instead of Percentage Errors in Forecast Evaluations, An Expanded Prediction-Realization Diagram for Assessing Forecast Errors, Forecast Error Measures: Critical Review and Practical Recommendations, Measuring the Quality of Intermittent Demand Forecasts: It's Worse than We've Thought! Managing Forecasts by Exception, Using Process Behavior Charts to Improve Forecasting and Decision Making, Can Your Forecast Beat the Naïve Forecast? **Process and Politics of Business Forecasting :** FVA: A Reality Check on Forecasting Practices, Where Should the Forecasting Function Reside? Setting Forecasting Performance Objectives, Using Relative Error Metrics to Improve Forecast Quality in the Supply Chain, Why Should I Trust Your Forecasts?, High on Complexity, Low on Evidence: Are Advanced Forecasting Methods Always as Good as They Seem?, Should the Forecasting Process Eliminate Face-to-Face Meetings? The Impact of Sales Forecast Game Playing on Supply Chains. Role of the Sales Force in Forecasting, Good and Bad Judgment in Forecasting: Lessons from Four Companies, Worst Practices in New Product Forecasting, Sales and Operations Planning in the Retail Industry, Sales and Operations Planning: Where Is It Going	**12**
III	**Artificial Intelligence and Machine Learning in Forecasting** : Deep Learning For Forecasting, Deep Learning For Forecasting: Current Trends And Challenges, Neural Network–Based Forecasting Strategies, Will Deep And Machine Learning Solve Our Forecasting Problems? Forecasting The Impact Of Artificial Intelligence: The Emerging And Long-Term Future, Forecasting The Impact Of Artificial Intelligence: Another Voice, Smarter Supply Chains Through Ai, Continual Learning: The Next Generation Of Artificial Intelligence, Assisted Demand Planning Using Machine Learning, Maximizing Forecast Value Add Through Machine Learning And Behavioral Economics, The M4 Forecasting Competition – Takeaways For The Practitioner **Big Data in Forecasting** : Is Big Data The Silver Bullet For Supply-Chain Forecasting? How Big Data Could Challenge Planning Processes Across The Supply Chain	**12**
IV	**Forecasting Methods**: Modeling, Selection, and Monitoring : Know Your Time Series, A Classification Of Business Forecasting Problems, Judgmental Model Selection, A Judgment On Judgment, Could These Recent Findings Improve Your Judgmental Forecasts? A Primer On Probabilistic Demand Planning, Benefits And Challenges Of Corporate Prediction Markets, Get Your Cov On, Standard Deviation Is Not The Way To Measure Volatility, Monitoring Forecast Models Using Control Charts, Forecasting The Future Of Retail Forecasting	**12**

	Forecasting Performance: Using Error Analysis To Improve Forecast Performance, Guidelines For Selecting A Forecast Metric, The Quest For A Better Forecast Error Metric: Measuring More Than The Average Error, Beware Of Standard Prediction Intervals From Causal Models	
V	**Forecasting Process**: Communication, Accountability, and S&OP : Not Storytellers But Reporters, Why Is It So Hard To Hold Anyone Accountable For The Sales Forecast? Communicating The Forecast: Providing Decision Makers With Insights, An S& Op Communication Plan: The Final Step In Support Of Company Strategy, Communicating Forecasts To The C-Suite: A Six-Step Survival Guide, How To Identify And Communicate Downturns In Your Business, Common S& Op Change Management Pitfalls To Avoid, Five Steps To Lean Demand Planning,The Move To Defensive Business Forecasting **Case Studies** : Business Demand Forecast Case Study, Sales Forecasting Case study, Demand Forecasting for a Call Centre, Market Trend for Product Forecasting	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Business Forecasting	Michael Gilliland, Len Tashman	Wiley	1st	2016
2.	Business Forecasting	Michael Gilliland, Len Tashman, et.al.	Wiley	1st	2021
3.	Demand-Driven Forecasting: A Structured Approach to Forecasting	Charles W. Chase Jr.	Wiley	2nd	2013
4.	Sales and Market Forecasting for Entrepreneurs	Tim Berry	Business Expert Press	1st	2010

Course Outcome:

Upon the successful completion of this course, students will be able to:

- Explain various notions/concepts/principles in time series analysis and forecasting.
- Choose and use the standard techniques of time series analysis to analyse real data, and build appropriate forecasting models.
- Review and interpret models and forecasting results critically.
- Construct written work, which is logically and professionally presented.
- Master a modern statistical computer language and Master problem solving as a team.

USDS505c: Marketing and Retail Analytics

B. Sc (Data Science)		Semester – V	
Course Name: Marketing and Retail Analytics		**Course Code: USDS505c**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
Marketing analytics enables marketers to measure, manage and analyse customer preferences and trends, as well as evaluate marketing performance to maximize its effectiveness. Students will develop an understanding how to use marketing analytics to predict outcomes.

Course Objectives:

- Students will have a command of business theory and practice in the field of business forecasting.
- To learn different forecasting models/techniques both quantitative and qualitative.
- Students will use reasoned and ethical judgment when analyzing problems and making decisions.
- Students will be able to understand complex business situations and provide solutions to improve current business practices.
- Students will be effective communicators.

Unit	Details	Lectures
I	Summarize Marketing Data, Pricing, Forecasting	**12**
II	Customer Analysis, Customer Value, Market Segmentation	**12**
III	Forecasting New Product Sales, Retailing, Advertising, Marketing Research Tools, Internet and Social Marketing	**12**
IV	Retailing Analytics: An Introduction, Retail and Data Analytics, Importance of Geography and Demographics	**12**
V	In-Store Marketing and Presentation, Store Operations and Retail Data, Loyalty Marketing	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Marketing Analytics	Wayne L. Winston	John Wiley & Sons	--	--
2.	Retailing Analytics	Emmett Cox	John Wiley & Sons	--	--

Course Outcome:

On successful completion of this course, students will be able to:
1. Demonstrate the use of analytical tools in marketing.
2. Choose appropriate data sources and analytical tools to assess marketing performance.
3. Apply analytics tools to a variety of data collected by marketers.
4. Translate the results of quantitative analyses into managerial insights for marketing decision-making.
5. Explain and illustrate how marketing analytics are used in an integrated manner to solve strategic marketing problems.

USDS5P5: Data Visualisation with Tableau Practical

B. Sc (Data Science)		Semester – V	
Course Name: Data Visualisation with Tableau Practical		**Course Code: USDS5P5**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Description:
This course introduces students to Tableau, a powerful data visualization and analytics tool. From installing Tableau Desktop to creating interactive dashboards and sharing insights, students will learn data preparation, visualization techniques, advanced analytics, and how to leverage Tableau Online, Tableau Server, and Tableau Public. Additionally, they will gain proficiency in data cleaning, formatting, and combining using Tableau Prep. By the end of the course, students will have the skills to analyze data effectively and create impactful visualizations with Tableau.

Course Objectives:

a. To familiarize students with the Tableau software and its key features.
b. To develop students' understanding of data preparation techniques and best practices in Tableau.
c. To enable students to create a variety of visualizations using different chart types and design principles in Tableau.
d. To introduce students to advanced analytics capabilities in Tableau for trend analysis, forecasting, and cluster analysis.
e. To equip students with the skills to share and present insights effectively using Tableau Online, Tableau Server, and Tableau Public.

Sr.	List of Practical
1.	Introduction to Tableau - Install, prepare data, navigate workspace, create visualizations, save/share workbooks.
2.	Adding Data Sources - Set up connectors, select tables, perform joins/unions, edit metadata, add hierarchies/calculated fields, optimize performance.
3.	Creating Data Visualizations - Explore chart types, design bar/line/highlight/heatmap/bullet charts, understand visualization anatomy.
4.	Aggregate Functions and Calculated Fields - Use aggregates/calculated fields, handle text/date fields, apply logical functions/parameters, search text fields.
5.	Table Calculations and Level of Detail Calculations - Perform different calculations, apply quick/customized table calculations, implement level of detail expressions.
6.	Maps in Tableau - Create symbol/filled/density maps, add layers/pie charts, use viz in tooltip, explore alternative map services, analyze spatial data.
7.	Advanced Analytics in Tableau - Identify trends/forecasts/clusters, utilize analytics pane, incorporate lines/forecasts, perform cluster analysis.
8.	Interactive Dashboards - Considerations for dashboard creation, create/place charts, add titles/navigation/buttons/actions, follow best practices.

9.	Sharing Insights with Tableau - Utilize Tableau Online/Server, publish to Tableau Public, embed visualizations in websites.
10.	Data Preparation with Tableau Prep - Connect to data, perform wildcard unions, inspect/clean/format data, remove unneeded fields, combine data with unions/joins, run/save flows.

Course Outcome:

Upon the successful completion of this course, students will be able to:

1. Students will be able to install Tableau Desktop and navigate the Tableau workspace proficiently.
2. Students will demonstrate competence in data preparation, including data connection, joining, data types, and calculated fields in Tableau.
3. Students will design and create visually compelling and informative visualizations using various chart types and visualization techniques in Tableau.
4. Students will utilize advanced analytics features in Tableau for trend analysis, forecasting, and cluster analysis.
5. Students will effectively share their visualizations and insights using Tableau Online, Tableau Server, and Tableau Public, and demonstrate an understanding of best practices in data sharing and presentation.

Semester VI

USDS601: Machine Learning

B. Sc (Data Science)		Semester – VI	
Course Name: Machine Learning		**Course Code: USDS601**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
This course introduces the field of Machine Learning (ML) and its various applications. Students will gain a comprehensive understanding of the underlying concepts, algorithms, and techniques used in ML. The course covers supervised and unsupervised learning methods, classification algorithms, regression models, performance evaluation metrics, clustering techniques, dimensionality reduction, and association rule mining. Students will also explore the advantages, disadvantages, and challenges associated with ML

Course Objectives:

- To introduce students to the fundamental concepts and principles of Machine Learning.
- To familiarize students with various types of machine learning algorithms and their applications.
- To provide hands-on experience in implementing and evaluating machine learning models.
- To develop critical thinking and problem-solving skills in the context of machine learning.
- To enable students to apply machine learning techniques to real-world problems and datasets.
- To understand the limitations and challenges of machine learning and develop strategies to address them.

Unit	Details	Lectures
I	**Introduction to Machine Learning:** Machine Learning(ML), Need for Machine Learning, ML from Knowledge-driven to Data Driven, Applications of Machine Learning, Problems suitable for Machine Learning, Advantages, Disadvantages and Challenges of Machine Learning, Challenges of ML. General architecture of ML systems, **Underlying Concepts in Machine Learning**: Inductive Learning, Generlization, Bias and Variance, Overfitting and Underfitting, Parametic and Non Parametric algorithms **Types of Machine Learning:** Supervised and Unsupervised Learning, Workflow, Semisupervised Learning, Reinforced Learning,	**12**
II	**Introduction to Classification Algorithms:** Concept of Classification, Binary classification, Multi-Class Classification, Multi Label Classification	**12**

	K-Nearest Neighbor Method: need and Working of KNN, Computing Distance, Pros and Cons of KNN, **Decsion Tree based Algorithm:** Terminologies and assumptions, Working of Decsion Trees, ID3 Alsogithm, Attribute selection Methods(Entropy, Gini Impurity, Information Gain)	
III	**Support Vector Machines:** Workin of SVM, SVM Concepts-Support Vectors, Hard Margin, soft Margin, Kernels, Advantages and Disadvantages of SVM **Probablistic Learning:** Introduction to Bayes Learning, Interpretation of Bayes Rule, Benefits and shortfalls of Bayesian Learning, Naïve Bayes Classifier, Chracteristics of Naïve Bayes **Regression Methods:** Linear Regression Models, Logistic Regression	**12**
IV	**Performance Evaluation:** Classification Metrics-Accuracy, Sensitivity, Precision, F1 Score, ROC/AUC Curve, Cross Validation **Unsupervised Learning:** Concept of unsupervised Learning, Importance and Challenges of unsupervised Learning, Clustering and its applications **Hierarchical Clusturing:** Introduction, Types of Hierarchical Clustering, Issues with Hierarchical Clustering,	**12**
V	**Partition algorithm:** K-means Clustering, steps of K-means Clustering, Issues, Stength and Weakness of K-means clustering. Curse of Dimensionality. **Dimensionality Reduction:** Crieteria for Reduction, Feature Reduction and Selection, Principal Component Analysis(PCA) **Association rule Mining:** Basic Concepts, Market Basket Analysis, and Apriori algorithm.	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Machine Learning: Concepts, Techniques and Applications	T V Geetha S, Sendhilkumar	CRC Press, Taylor and Francis	1st Edition	2023
2.	Machine Learning for Decision Sciences with Case Studies in Python	S. Sumathi, Suresh V. Rajappa	CRC Press, Taylor and Francis	1st Edition	2022
3.	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media, Inc.	1st Edition	2016
4.	Machine Learning for Beginners	Harsh Bhasin	BPB	1st Edition	2020
5.	Machine Learning	S Sridhar	Oxford University Press	1st Edition	2021
6.	Machine Learning	Ruchi Doshi, Kamal Kant Hiran	BPB	1St Edition	2021

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand the foundational concepts and principles of Machine Learning
- Apply supervised and unsupervised learning techniques, including classification algorithms and clustering algorithms
- Evaluate the performance of Machine Learning models using classification metrics, ROC/AUC curve analysis, and cross-validation techniques.
- Implement regression models (such as linear regression and logistic regression) and understand their applications in predictive analysis.
- Utilize dimensionality reduction techniques (Like PCA) for feature reduction and selection, and apply association rule mining algorithms (such as the Apriori algorithm) for discovering meaningful patterns in datasets.

USDS6P1: Machine Learning Practical

B. Sc (Data Science)		Semester – VI	
Course Name: Machine Learning Practical		**Course Code: USDS6P1**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Description:

This course provides hands-on experience in implementing various machine learning algorithms and techniques. Students will gain proficiency in applying classification algorithms like K-Nearest Neighbor (KNN), decision trees, Support Vector Machines (SVM), and Naïve Bayes, as well as regression models such as linear regression and logistic regression. They will also learn about evaluating model performance, utilizing clustering techniques like hierarchical clustering and K-means clustering, and applying dimensionality reduction methods, particularly Principal Component Analysis (PCA). Through practical exercises using real-world datasets, students will develop the necessary skills to implement and assess machine learning models effectively.

Course Objectives:

- Gain practical experience in implementing machine learning algorithms.
- Apply machine learning techniques to real-world datasets and problem scenarios.
- Develop skills in model evaluation and performance assessment.

List of Suggested Practical

Sr	Practical Details
1	Implementing a K-Nearest Neighbor (KNN) algorithm (e.g. to classify handwritten digits).
2	Building a decision tree model using the ID3 algorithm (e.g. to predict whether a customer will churn or not).
3	Developing a Support Vector Machine (SVM) model (e.g. to classify email messages as spam or not spam).
4	Building a Naïve Bayes classifier (e.g. to classify movie reviews as positive or negative sentiment).
5	Implementing linear regression (e.g. to predict housing prices based on features such as size and location).
6	Using logistic regression (e.g. to predict whether a credit card transaction is fraudulent or not).
7	Evaluating a classification model using metrics such as accuracy, precision, recall, and F1 score.
8	Applying hierarchical clustering (e.g. to group customer segments based on their purchasing behavior).
9	Implementing the K-means clustering algorithm (e.g. to identify distinct clusters in a customer demographic dataset).
10	Utilizing Principal Component Analysis (PCA) for dimensionality reduction to improve the efficiency and interpretability of a model.

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Practical implement machine learning algorithms such as KNN, decision trees, SVM, Naïve Bayes, linear regression, and logistic regression.
- Apply these algorithms to real-world datasets and problem scenarios.
- Be Proficient in evaluating and assessing the performance of machine learning models using appropriate metrics.
- Apply clustering techniques, including hierarchical clustering and K-means clustering, for grouping and segmentation tasks.
- Understanding and practical application of dimensionality reduction techniques, particularly PCA, for feature extraction and interpretation.

USDS602: Exploratory Data Analysis

B. Sc (Data Science)		Semester – VI	
Course Name: Exploratory Data Analysis		**Course Code: USDS602**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
Exploratory data analysis (EDA) is used by data scientists to analyse and investigate data sets and summarize their main characteristics, often employing data visualization methods. It helps determine how best to manipulate data sources to get the answers you need, making it easier for data scientists to discover patterns, spot anomalies, test a hypothesis, or check assumptions. EDA is primarily used to see what data can reveal beyond the formal modelling or hypothesis testing task and provides a provides a better understanding of data set variables and the relationships between them. It can also help determine if the statistical techniques you are considering for data analysis are appropriate.

Course Objectives:
- To understand importance of data and its types in Exploratory Data Analysis.
- To understand difference between EDA and summary statistics in context of interpretation.
- To understand the importance of data pre-processing for Exploratory Data Analysis.
- To understand the significance of missing value imputations in better EDA interpretations.
- To understand the importance measure of central tendency in describing the quick view of data set.
- To understand the importance of measure of dispersion and its interpretation in spread ness of data.

Unit	Details	Lectures
I	**INTRODUCTION TO DATA AND ITS TYPES** : Definition and importance of data, classification of data : based on observation – Cross Sectional, times series and panel data, based on measurement – ratio, interval, ordinal and nominal, based on availability – primary, secondary, tertiary, based on structural form – structured, semi structured and unstructured, based on inherent nature – quantitative and qualitative, concepts on sample data and population, small sample and large sample, statistic and parameter, types of statistics and its application in different business scenarios, frequency distribution of data.	**12**
II	**INTRODUCTION TO EXPLORATORY DATA ANALYSIS (EDA)** : Definition of EDA, difference between EDA with classical and Bayesian Analysis, comparison of EDA with Classical data summary measures, goals of EDA, Underlying assumptions in EDA, importance of EDA in data exploration techniques, introduction to	**12**

	different techniques to test the assumptions involved in EDA, role of graphics in data exploration, introduction to unidimensional, bidimensional and multidimensional graphical representation of data.	
III	**DATA PREPARATION**: Introduction to data exploration process for data preparation, data discovery, issues related with data access, characterization of data, consistency and pollution of data, duplicate or redundant variables, outliers and leverage data, noisy data, missing values, imputation of missing and empty places, with different techniques, missing pattern and its importance, handling non numerical data in missing places.	**12**
IV	**UNIVARIATE DATA ANALYSIS**: Description and summary of data set, measure of central tendency – mean: Arithmetic, geometric and harmonic mean – Raw and grouped data, confidence limit of mean, median, mode, quartile and percentile, interpretation of quartile and percentile values, measure of dispersion, concepts on error, range, variance, standard deviation, confidence limit of variance and standard deviation, coefficient of variation, mean absolute deviation, mean deviation, quartile deviation, interquartile range, concepts on symmetry of data, skewness and kurtosis, robustness of parameters, measures of concentration.	**12**
V	**BIVARIATE DATA ANALYSIS**: Introduction to bivariate distributions, association between two nominal variables, contingency tables, Chi-Square calculations, Phi Coefficient, scatter plot and its causal interpretations, correlation coefficient, regression coefficient, relationship between two ordinal variables – Spearman Rank correlation, Kendall's Tau Coefficients, measuring association between mixed combination of numerical, ordinal and nominal variables.	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Exploratory Data Analysis	John W Tukey	Addison Wesley	1st	1977
2.	Exploratory Data Analysis in Business and Economics	Thomas Cleff	Springer	1st	2014
3.	Graphical Exploratory Data Analysis	S.H.C. du Toit A.G.W. Steyn R.H. Stumpf	Springer	1st	1986
4.	Hand book of Data Visualization	Chun-houh Chen, Wolfgang Härdle	Springer	1st	2008

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand importance of data and its types in Exploratory Data Analysis.
- Classify EDA and summary statistics in context of interpretation.
- Understand the significance of missing value imputations in better EDA interpretations.
- Analyse the measure of central tendency in describing the quick view of data set.
- Categorize measure of dispersion and its interpretation in spread ness of data.

USDS5P2: Exploratory Data Analysis Practical

B. Sc (Data Science)		**Semester – VI**	
Course Name: Exploratory Data Analysis Practical		**Course Code: USDS6P2**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Objectives:

1. Understand the data and its types for the appropriate exploratory data analysis.
2. Understand the importance of Exploratory Data Analysis over summary statistics.
3. Understand the importance Univariate statistics in EDA
4. Plot Univariate statistical graphs for the better representation and interpretation.
5. Plot bivariate statistical graphs for the better representation and interpretation.

List of Suggested Practical

Sr.	**Practical Details**
1	Managing Data Frames with the dplyr package
2	Use dplyr Grammar for inbuilt data set car.
3	Use group by(), %>%,mutate(), rename(),arrange(), filter(), select()
4	Use the data set air quality from inbuilt data sets library. a) Use summary statistics and find the important key values from the output b) Use boxplot and find the interquartile range. Interpret the boxplot and inner and outer fencing of outliers c) Check the missing value in the data set and fine the suitable solution for the missing values. d) Using histogram, find the distribution of data and give proper comment over the dataset.
5	Use bar plot and identify the difference between bar plot and histograms. Conclude the appropriate use of bar plot and histogram.
6	Explore the two dimensional data
7	Scatter plot between two variables
8	Five number summary in exploratory data analysis
9	Multiple histogram and multiple boxplots, Multiple scatter plots and colouring the graph
10	Lattice system in R environment and Graphical window in R and its uses

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Experiment with exploratory data analysis; use its features in the field of data science.
- Make use of data and its types for the appropriate exploratory data analysis.
- Understand the importance of Exploratory Data Analysis over summary statistics.
- Interpret and make use of Univariate statistics in EDA
- Build Univariate statistical graphs for the better representation and interpretation.
- Build bivariate statistical graphs for the better representation and interpretation.

USDS603: Internet of Things

B. Sc (Data Science)		Semester – VI	
Course Name: Internet of Things (IOT)		**Course Code: USDS603**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:
The internet of things lies at the intersection of the physical and digital world. Across industries, it encompasses an extensive network of web-connected devices that use embedded systems like sensors and processors to collect, analyze, and act on data from various environments. Through their connection to the internet, each device can communicate over a network without needing human intervention, which can come in handy for many different tasks.
This course is designed to give an overview of the Internet of Things graduate certificate. It closely maps to subject focus areas, and is intended to assist the student in understanding the focus areas. The faculty in this short course also teach graduate courses within the IoT graduate certificate.

Course Objectives:

- To learn the main elements of Internet of Things (IoT) systems and how to design and build them.
- To learn embedded programming and IoT hardware components such as microprocessors, microsensors and energy harvesters
- To understand how data moves between devices, apps and the cloud
- To able to design & develop application based IOT Devices
- To learn the infrastructure for supporting IoT deployments.

Unit	Details	Lectures
I	**The Internet of Things: An Overview**: The Flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things? **Design Principles for Connected Devices:** Calm and Ambient Technology, Magic as Metaphor, Privacy, Keeping Secrets, Whose Data Is It Anyway? Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens on The Internet, Graceful Degradation, Affordances. **Internet Principles:** Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols, HTTP, **HTTPS**: Encrypted HTTP, Other Application Layer Protocols.	**12**
II	**Thinking About Prototyping:** Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Changing Embedded Platform, Physical Prototypes and Mass Personalisation, climbing into the Cloud, Open Source versus Closed Source, Why Closed? Why	**12**

	Open? Mixing Open and Closed Source, Closed Source for Mass Market Projects, Tapping into the Community. **Prototyping Embedded Devices:** Electronics, Sensors, Actuators, Scaling Up the Electronics, Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, developing on the Arduino, Some Notes on the Hardware, Openness, Raspberry Pi, Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness.	
III	**Prototyping the Physical Design:** Preparation, Sketch, Iterate, and Explore, Nondigital Methods, Laser Cutting, Choosing a Laser Cutter, Software, Hinges and Joints, 3D Printing, Types of 3D Printing, Software, CNC Milling, Repurposing/Recycling. **Prototyping Online Components:** Getting Started with an API, Mashing Up APIs, Scraping, Legalities, writing a New API, Clockodillo, Security, implementing the API, Using Curl to Test, Going Further, Real-Time Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol.	**12**
IV	**Techniques for Writing Embedded Code:** Memory Management, Types of Memory, Making the Most of Your RAM, Performance and Battery Life, Libraries,Debugging. **Business Models:** A Short History of Business Models, Space and Time, From Craft to Mass Production, The Long Tail of the Internet, Learning from History, The Business Model Canvas, Who Is the Business Model For? Models, Make Thing, Sell Thing, Subscriptions, Customisation, be a Key Resource, Provide Infrastructure: Sensor Networks, take a Percentage, Funding an Internet of Things Startup, Hobby Projects and Open Source, Venture Capital, Government Funding, Crowdfunding, Lean Startups.	**12**
V	**Moving to Manufacture:** What Are You Producing? Designing Kits, Designing Printed circuit boards, Software Choices, The Design Process, Manufacturing Printed Circuit Boards, Etching Boards, Milling Boards. Assembly, Testing, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software, Deployment, Correctness and Maintainability, Security, Performance, User Community. **Ethics:** Characterizing the Internet of Things, Privacy, Control, Disrupting Control,Crowdsourcing, Environment, Physical Thing, Electronics, Internet Service, Solutions, The Internet of Things as Part of the Solution, Cautious Optimism, The Open Internet of Things Definition.	**12**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Designing the Internet of Things	Adrian McEwen, Hakim Cassimally	WILEY	1st	2014
2.	Internet of Things – Architecture and Design	Raj Kamal	McGraw Hill	1st	2017
3.	Getting Started with the Internet of Things	Cuno Pfister	O"Reilly	6th	2018
4.	Getting Started with Raspberry Pi	Matt Richardson and Shawn Wallace	SPD	3rd	2016

Course Outcome:

Upon the successful completion of this course, students will be able to:

- Describe what IoT is and how it works today and Recognise the factors that contributed to the emergence of IoT
- Design and program IoT devices and Use real IoT protocols for communication
- Secure the elements of an IoT device
- Design an IoT device to work with a Cloud Computing infrastructure.
- Transfer IoT data to the cloud and in between cloud providers and Define the infrastructure for supporting IoT deployments

USDS6P3: Internet of Things Practical

B. Sc (Data Science)		Semester – VI	
Course Name: Internet of Things Practical		**Course Code: USDS6P3**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Objectives:

- To Learn the concept of Internet of Things
- To understand interfacing of various sensors with Arduino/Raspberry Pi.
- To learn to transmit data wirelessly between different devices.
- To understand how to upload/download sensor data on cloud and server.
- To learn various SQL queries from MySQL database.

Sr	Practical Details
0	Starting Raspbian OS, Familiarising with Raspberry Pi Components and interface, Connecting to ethernet, Monitor, USB.
1	Displaying different LED patterns with Raspberry Pi.
2	Displaying Time over 4-Digit 7-Segment Display using Raspberry Pi
3	Raspberry Pi Based Oscilloscope
4	Controlling Raspberry Pi with telegram bot.
5	Fingerprint Sensor interfacing with Raspberry Pi
6	Raspberry Pi GPS Module Interfacing
7	IoT based Web Controlled Home Automation using Raspberry Pi
8	Visitor Monitoring with Raspberry Pi and Pi Camera
9	Interfacing Raspberry Pi with RFID.
10	Installing Windows 10 IoT Core on Raspberry Pi

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand the concept of Internet of Things
- Implement interfacing of various sensors with Arduino/Raspberry Pi.
- Demonstrate the ability to transmit data wirelessly between different devices.
- Demonstrate an ability to upload/download sensor data on cloud and server.
- Examine various SQL queries from MySQL database.

USDS604: Applied Business Analytics

B. Sc (Data Science)		Semester – VI	
Course Name: Applied Business analytics		**Course Code: USDS604**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:

The applied business analytics course is designed for students keen to advance their knowledge on data analytics. The dynamic curriculum in applied business analytics helps the participant to understand and apply analytics in the business context. Topics covered are fundamentals of probabilities, linear regression, and other business data analysis using Microsoft excel. Business cases from marketing analytics, HR analytics, financial analytics and operation analytics are covered as part of this course.

Course Objectives:

- To learn basics of statistical concepts like probability distribution, hypothesis testing etc.
- To learn about Business Intelligence Tools for Data Analysis.
- To learn about the business analytics methods for discovering the knowledge
- To understand Regression Analysis with Time Series Analysis and forecasting
- To learn to understand various modelling techniques for Optimization and simulation.

Unit	Details	Lectures
I	Introduction to business analytics, describing the distribution of a variable, finding relationships among variables	**12**
II	Business Intelligence Tools for Data Analysis, Probability and Probability Distributions, Decision making under uncertainty.	**12**
III	Sampling and Sampling Distributions, Confidence Interval Estimation, Hypothesis Testing	**12**
IV	Regression Analysis: Estimating Relationships, Regression Analysis: Statistical Inference, Time Series Analysis and forecasting	**12**
V	Optimization modelling, simulation modelling, analysis of variance and experimental design	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Business Analytics Data Analysis and decision making	S.Christian Albright and Wayne L. Winston	Cengage	7th	2020
2.	The Applied Business Analytics Casebook:	Matthew Drake	O'Reilly	3rd	2013

	Applications in Supply Chain Management, Operations Management, and Operations Research				
3.	Applied Business Analytics: Integrating Business Process, Big Data, and Advanced Analytics	Nathaniel Lin	FT Press Analytics	1st	2015

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Understand basics of statistical concepts like probability distribution, hypothesis testing etc.
- Experiment with Business Intelligence Tools for Data Analysis.
- Make use of the business analytics methods for discovering the knowledge
- Apply Regression Analysis with Time Series Analysis and forecasting
- Apply and Construct various modelling techniques for Optimization and simulation.

USDS6P4: Applied Business Analytics Practical

B. Sc (Data Science)		Semester – VI	
Course Name: Applied Business Analytics Practical		**Course Code: USDS6P4**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Description:
This course " provides students with practical skills in using analytics techniques to solve real-world business problems. The course covers various topics, including data analysis, probability, hypothesis testing, regression analysis, time series analysis, optimization modeling, and experimental design. Students will learn how to collect, analyze, and interpret data to make informed business decisions. They will also gain proficiency in using business intelligence tools and programming languages such as Python for data analysis and visualization.

Course Objectives:

a. Develop a solid understanding of the fundamental concepts and techniques in business analytics.
b. Acquire practical skills in data collection, data exploration, and descriptive statistics.
c. Apply statistical methods to analyze relationships between variables and make informed business decisions.
d. Utilize business intelligence tools and programming languages for data analysis and visualization.
e. Gain hands-on experience in applying various analytics techniques such as regression analysis, time series analysis, optimization modeling, and experimental design to solve business problems.

Sr	Practical Details
1.	Introduction to Business Analytics: a. Collect data from a real-life business scenario and perform exploratory data analysis (EDA) to gain insights into the dataset. b. Analyze customer data to identify trends and patterns that can be used for business decision-making.
2.	Describing the Distribution of a Variable: a. Obtain a dataset and calculate descriptive statistics (mean, median, mode, variance, etc.) for a specific variable of interest. b. Create visualizations (histograms, box plots) to depict the distribution of a variable and analyze its characteristics.
3.	Finding Relationships Among Variables: a. Use a dataset with multiple variables and perform correlation analysis to determine the strength and direction of relationships between pairs of variables. b. Apply regression analysis to identify the relationship between an independent variable (e.g., advertising expenditure) and a dependent variable (e.g., sales revenue).

4.	Business Intelligence Tools for Data Analysis: a. Utilize a business intelligence tool (e.g., Tableau, Power BI) to extract insights from a dataset and create interactive visualizations for effective data analysis.
5.	Probability and Probability Distributions: a. Simulate a probability experiment (e.g., rolling dice) using programming and calculate the probabilities of different outcomes. b. Generate random numbers from various probability distributions (normal, uniform, exponential) and analyze their properties.
6.	Decision Making under Uncertainty: a. Develop a decision tree model to make business decisions considering uncertainties and associated probabilities at each decision point. b. Apply the concept of expected value to evaluate different decision alternatives and select the optimal one.
7.	Sampling and Sampling Distributions: a. Conduct a survey and collect data from a sample population, ensuring proper sampling techniques are employed. b. Use the Central Limit Theorem to analyze the sampling distribution of a sample mean and estimate population parameters.
8.	Confidence Interval Estimation: a. Calculate confidence intervals for population means or proportions using sample data and interpret the results in a business context. b. Apply bootstrapping techniques to estimate confidence intervals for non-parametric statistics.
9.	Hypothesis Testing: a. Formulate null and alternative hypotheses related to a business problem, conduct a hypothesis test using appropriate statistical tests, and interpret the results. b. Perform A/B testing on a website or marketing campaign to evaluate the effectiveness of different strategies and make data-driven decisions.
10.	Regression Analysis and Time Series Analysis: a. Develop a regression model to predict future sales based on historical data, assess model performance, and interpret the significance of predictor variables. b. Apply time series analysis techniques (e.g., ARIMA, exponential smoothing) to forecast future demand for a product or service, and evaluate the accuracy of the forecasts.
11.	Optimization Modeling and Simulation Modeling: a. Formulate an optimization model (e.g., linear programming, integer programming) to solve a real-world business problem and analyze the optimal solution. b. Use simulation modeling to evaluate different business scenarios, such as capacity planning, inventory management, or pricing strategies, and assess their impact on performance metrics.
12.	Analysis of Variance and Experimental Design: a. Design and conduct an experiment to study the effects of different factors on a specific response variable, analyze the results using analysis of variance (ANOVA), and draw conclusions. b. Implement a factorial experiment and analyze the main effects and interaction effects of factors using statistical techniques.

Course Outcomes:

Upon the successful completion of this course, students will be able to:

1. Apply data analysis techniques effectively.
2. Analyze relationships among variables for informed decision-making.
3. Utilize business intelligence tools for data analysis and visualization.
4. Make optimal decisions under uncertainty.
5. Conduct statistical inference for making meaningful conclusions.
6. Apply advanced analytics techniques to solve complex business problems.

USDS605a: Sports Analytics

B. Sc. (Data Science)		Semester – VI	
Course Name: Descriptive Statistics		**Course Code: USDS605a**	
Periods per week (1 Period is 50 minutes)		**5**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Objectives:

- To understand the Cricket analytics and cricketr package.
- To understand the use of cricketr package for analysing performances of cricketers.
- To understand the use of cricketr package template.
- To understand the use of Cricpy package for analysing performances of cricketers.
- To understand Cricket analysis with Machine Learning using Octave.

Unit	Details	Lectures
I	Introduction, Cricket analytics with cricketr, Introducing cricketr! : An R package to analyze performances of cricketers, Taking cricketr for a spin – Part 1, cricketr digs the Ashes!	**12**
II	cricketr plays the ODIs! cricketr adapts to the Twenty20 International! Sixer – R package cricketr's new Shiny avatar, Re-introducing cricketr: An R package to analyze performances of cricketers	**12**
III	cricketr sizes up legendary All-rounders of yesteryear, cricketr flexes new muscles: The final analysis, The Clash of the Titans in Test and ODI cricket, Analyzing performances of cricketers using cricketr template	**12**
IV	Cricket analytics with cricpy, Introducing cricpy:A python package to analyze performances of cricketers, Cricpy takes a swing at the ODIs Analysis of Top 4 batsman	**12**
V	Cricpy takes guard for the Twenty20s, Analyzing batsmen and bowlers with cricpy template, Average runs against different opposing teams, Other cricket posts in R, Analyzing cricket's batting legends – Through the mirage with R, Mirror, mirror … the best batsman of them all? Cricket analysis with Machine Learning using Octave, Informed choices through Machine Learning – Analyzing Kohli, Tendulkar and Dravid, Informed choices through Machine Learning-2 Putting together Kumble, Kapil, Chandra	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Cricket analytics with cricketr and cricpy : Analytics harmony with R and Python	Tinniam V Ganesh	Paperback	4th	2023

2.	Cricket 2.0: Inside the T20 Revolution	Tim Wigmore & Freddie Wilde	Treeshade	1st	2022
3.	The Three Ws of West Indian Cricket: A Comparative Batting Analysis	Keith A. P. Sandiford & Arjun Tan	Paperback	1st s	2002

Course Outcomes:
After completion of the course, a student should be able to:

- To remember and understand the Cricket analytics and its procedures.
- To apply cricketr package for analysing performances of cricketers.
- To understand the use of cricketr package template.
- To analysing performances of cricketers using of Cricpy package.
- To apply and evaluate Cricket analysis with Machine Learning using Octave.

USDS605b: Healthcare Analytics

B. Sc (Data Science)		Semester – VI	
Course Name: Healthcare Analytics		**Course Code: USDS605b**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:

Health care analytics is a subset of data analytics that uses both historic and current data to produce actionable insights, improve decision making, and optimize outcomes within the health care industry. Health care analytics is not only used to benefit health care organizations but also to improve the patient experience and health outcomes.

The health care industry is awash with valuable data in the form of detailed records. Industry regulations stipulate that health care providers must retain many of these records for a set period of time.

This means that health care has become a site of interest for those working with "big data," or large pools of unstructured data. As a still-developing field, big data analytics in health care offers the potential to reduce operation costs, improve efficiency, and treat patients.

Course Objectives:

- To learn basics about Healthcare Analytics.
- To understand the attributes of Electronic Medical Record to learn about Computing Foundation.
- To understand Measuring Techniques of Healthcare Quality.
- To learn about Making Predictive Models in Healthcare.
- To know about Various Healthcare Predictive Models and learn about Healthcare and Emerging Technologies.

Unit	Details	Lectures
I	**Introduction to Healthcare Analytics**: What is healthcare analytics? Healthcare analytics uses advanced computing technology, Healthcare analytics acts on the healthcare industry, Healthcare analytics improves medical care, Foundations of healthcare analytics, Healthcare, Mathematics, Computer science, History of healthcare analytics, Examples of healthcare analytics, Using visualizations to elucidate patient care, Predicting future diagnostic and treatment events, Measuring provider quality and performance, Patient-facing treatments for disease **Healthcare Foundations:** Healthcare delivery, Healthcare industry basics, Healthcare financing, Healthcare policy **Electronic Medical Record-1**: The history and physical, Metadata and chief complaint, History of the present illness, Past medical history, Medications, Family history, Social history, Allergies, Review of systems, Physical examination, Additional objective data (lab tests, imaging, and other diagnostic tests), Assessment and plan	**12**
II	**Electronic Medical Record-2 :** The progress (SOAP) clinical note, Standardized clinical codesets, International Classification of Disease (ICD),	**12**

	Current Procedural Terminology (CPT), Logical Observation Identifiers Names and Codes (LOINC), National Drug Code (NDC), Systematized Nomenclature of Medicine Clinical Terms (SNOMED-CT), Breaking down healthcare analytics, Population, Medical task, Data format, Disease **Machine Learning Foundations** : Model frameworks for medical decision making, Tree-like reasoning, Probabilistic reasoning and Bayes theorem, Criterion tables and the weighted sum approach, Pattern association and neural networks, Machine learning pipeline, Loading the data, Cleaning and preprocessing the data, Exploring and visualizing the data, Selecting features, Training the model parameters, Evaluating model performance **Computing Foundations :** Introduction to databases, Data engineering with SQL, Case details : Predicting mortality for a cardiology practice, Starting an SQLite session, Data engineering, one table at a time with SQL	
III	**Measuring Healthcare Quality** : Introduction to healthcare measures, US Medicare value-based programs, The Hospital Value-Based Purchasing (HVBP) program, Domains and measures, The clinical care domain, The patient- and caregiver-centered experience of care domain, Safety domain, Efficiency and cost reduction domain, The Hospital Readmission Reduction (HRR) program, The Hospital-Acquired Conditions (HAC) program, The healthcare-acquired infections domain, The patient safety domain, The End-Stage Renal Disease (ESRD) quality incentive program, The Skilled Nursing Facility Value-Based Program (SNFVBP), The Home Health Value-Based Program (HHVBP), The Merit-Based Incentive Payment System (MIPS), Quality, Advancing care information, Improvement activities, Cost, Other value-based programs, The Healthcare Effectiveness Data and Information Set (HEDIS), State measures, Comparing dialysis facilities using Python, Downloading the data, Importing the data into your Jupyter Notebook session, Exploring the data rows and columns,Exploring the data geographically, Displaying dialysis centers based on total performance, Alternative analyses of dialysis centers, Comparing hospitals, Downloading the data, Importing the data into your Jupyter Notebook session, Exploring the tables, Merging the HVBP tables	**12**
IV	**Making Predictive Models in Healthcare** : Introduction to predictive analytics in healthcare, Our modeling task predicting discharge statuses for ED patients, Obtaining the dataset, The NHAMCS dataset at a glance, Downloading the NHAMCS data, Downloading the ED2013 file, Downloading the list of survey items, Downloading the documentation file, Starting a Jupyter session, Importing the dataset, Loading the metadata, Loading the ED dataset, Making the response variable, Splitting the data into train and test sets, Preprocessing the predictor variables, Visit information, Month, Day of the week, Arrival time, Wait time, Other visit information, Demographic variables, Age, Sex, Ethnicity and race, Other demographic information, Triage variables, Financial variables, Vital signs, Temperature, Pulse, Respiratory rate, Blood pressure, Oxygen saturation, Pain level, Reason-for-visit codes, Injury codes, Diagnostic codes, Medical history, Tests, Procedures, Medication codes, Provider information, Disposition information, Imputed columns, Identifying variables, Electronic medical record status columns, Detailed medication information, Miscellaneous information, Final preprocessing steps, One-hot encoding, Numeric conversion, NumPy array conversion, Building the models, Logistic regression, Random forest, Neural network, Using the models to make predictions, Improving our models	**12**
V	**Healthcare Predictive Models:** Predictive healthcare analytics, Overall cardiovascular risk, The Framingham Risk Score,	**12**

	Cardiovascular risk and machine learning, Congestive heart failure, Diagnosing CHF, CHF detection with machine learning, Other applications of machine learning in CHF, Cancer, What is cancer? ML applications for cancer, Important features of cancer, Routine clinical data, Cancer-specific clinical data, Imaging data, Genomic data, Proteomic data, breast cancer prediction, Traditional screening of breast cancer, Breast cancer screening and machine learning, Readmission prediction, LACE and HOSPITAL scores, Readmission modelling, Other conditions and events **Healthcare and Emerging Technologies**: Healthcare analytics and the internet, Healthcare and the Internet of Things, Healthcare analytics and social media, Healthcare and deep learning, What is deep learning, briefly? Deep learning in healthcare, Obstacles, ethical issues, and limitations, Obstacles, Ethical issues, Limitations	

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Healthcare Analytics Made Simple	Vikas Kumar	Packt Publishing	1st	2018
2.	Healthcare Analytics: Foundations and Frontiers	Ross M. Mullner Edward M. Rafalski	T&F / Routledge	1st	2020
2.	Hands-On Healthcare Data	Andrew Nguyen	Shroff / O'Reilly	1st	2022
4.	AI-First Healthcare: AI Applications	Kerrie L. Holley	Shroff / O'Reilly	1st	2021
5.	Healthcare Data Analytics	Chandan K. Reddy, Charu C. Aggarwal	Chapman and Hall/CRC	1st	2020

Course Outcome:

Upon the successful completion of this course, students will be able to:

- Remember and relate Healthcare Analytic basics.
- Understand and Experiment with the attributes of Electronic Medical Record to learn about Computing Foundation.
- Apply and Evaluate Measuring Techniques of Healthcare Quality.
- Design and Build Predictive Models in Healthcare.
- Discuss and Modify Various Healthcare Predictive Models and learn about Healthcare and Emerging Technologies.

USDS605c: Data Governance

B. Sc (Data Science)		Semester – VI	
Course Name: Data Governance		**Course Code: USDS605c**	
Periods per week (1 Period is 50 minutes)		**5**	
Credit		**2**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**2½**	**75**
	Internal	**--**	**25**

Course Description:

This course provides a comprehensive overview of Data Governance, focusing on its importance, principles, processes, and tools. Students will learn about the fundamental concepts and practices of Data Governance, including its role in driving business value and the impact of data on organizational outcomes. The course covers various aspects of Data Governance, such as the development and implementation of Data Governance programs, considerations for Data Governance in the public cloud, and the management of data throughout its life cycle. Additionally, the course explores topics related to data quality, data protection, monitoring, and the establishment of a culture of data privacy and security.

Course Objectives:

- Understand the concept of Data Governance and its significance in organizations.
- Identify the roles and responsibilities of individuals involved in Data Governance initiatives.
- Explore the tools and processes used in Data Governance, including the enterprise dictionary and policy management.
- Learn how to apply Data Governance practices throughout the data life cycle, from data transformation to monitoring and change management.
- Develop the skills to design and implement effective Data Governance programs that align with organizational priorities and goals.

Unit	Details	Lectures
I	**Introduction to Data Governance:** Understanding Data Governance, Why Data Governance is important? Examples of Data Governance in Action, Business Value of Data Governance, Developing a Data Governance, Preparing for Data Governance, Data Governance in Public Cloud **Driving Values through Data:** Understanding Impact of Bigdata, Identifying the Roles of data, improving outcomes with data,	**12**
II	**Ingredients of of Data Governance Tools:** The Enterprise Dictionary, The People: Roles, Responsibilities, and Hats, The Process- Diverse Companies, Diverse Needs and Approaches to Data, People and Process Together- Considerations, Issues, and Some Successful Strategies **Data Governance over a Data Life Cycle:** What Is a Data Life Cycle? Phases of a Data Life Cycle, Data Life Cycle Management, Applying Governance over the Data Life Cycle, Operationalizing Data Governance	**12**

	Governance of Data: Data Transformance, Lineage, Policy Management, Simulation, Monitoring, Change Management	
III	**Developing Data Governance:** Organisations priorities and outcomes, Identifying data governance roles and responsibilities, Data Governance leadership groups, Designing and Implementing Data Governance Program **Improving Data Quality:** Data Quality, Its Importance, Data Quality as part of Data Governance Program,	**12**
IV	**Data Protection:** Planning Protection, Data Protection in the Cloud, Physical Security, Data Exfiltration, Identity and Access Management, Keeping Data Protection Agile, Data Protection Best Practices **Monitoring**: What is Monitoring? Why and who should perform monitoring? Monitoring system, Monitoring Criteria and Process	**12**
V	**Culture of Data Privacy and Security:** Data Culture, Benefits of Data Governance to Business, Intension, Training, and Communications, Maintaining Agility, Interplay with Legal and Security, Incident Handling, Transparency, Responding to data governance challenges and risks	**12**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Data Governance The Definitive Guide	Evren Eryurek, Uri Gilad, Valliappa Lakshmanan	O'Reilly	1st Edition	2021
2.	Data Governance for Dummies	Jonathan Reichenta	Wiley	1st Edition	2023
3.	Practitioner's Guide to Operationalizing Data Governance	Mary Anne Hopper	Wiley	1st Edition	2023
4.	Data Governance for Managers	Lars Michael Bollweg	Springer	1st Edition	2022
5.	Data Governance and Data Management: Contextualizing Data Governance Drivers, Technologies, and Tools	Rupa Mahanti	Springer	1st Edition	2021

Course Outcomes:

Upon the successful completion of this course, students will be able to:

- Demonstrate a comprehensive understanding of Data Governance, including its importance and benefits for organizations.
- Analyze real-world examples of Data Governance in action and evaluate their impact on business value.
- Apply Data Governance principles and tools, such as the enterprise dictionary and policy management, to support effective data management practices.
- Implement Data Governance practices throughout the data life cycle and effectively operationalize Data Governance within an organization.
- Develop strategies for improving data quality, ensuring data protection, establishing effective monitoring systems, and fostering a culture of data privacy and security.

USDS6P5: Project Dissertation and Implementation – 2

B. Sc (Data Science)		Semester – VI	
Course Name: Project Dissertation and Implementation – 2		**Course Code: USDS6P5**	
Periods per week (1 Period of 50 minutes)		**3**	
Credits		**2**	
		Hours	**Marks**
Evaluation System	**Practical Examination**	**2½**	**50**
	Internal	**--**	**--**

Course Description:
The Project Implementation course in B.Sc Data Science builds upon the knowledge and skills acquired in previous semesters, focusing on the practical implementation of data science projects. Students will work on real-world projects, applying data science methodologies and techniques to solve complex problems. They will gain hands-on experience in data collection, preprocessing, feature engineering, and model development. Through project management and teamwork, students will learn to effectively plan, execute, and monitor projects. The course emphasizes critical thinking and problem-solving, enabling students to analyze project outcomes and propose recommendations for improvement.

Course Objectives:

1. To enable students to apply the knowledge and skills acquired during the B.Sc Data Science program in the implementation of a data science project.
2. To provide students with hands-on experience in implementing data science methodologies and techniques to solve real-world problems.
3. To develop students' project management skills by planning, executing, and monitoring a data science project.
4. To enhance students' collaboration and teamwork abilities by working in groups to implement a data science project.
5. To foster students' critical thinking and problem-solving skills by addressing challenges and making informed decisions during the project implementation phase.

The documentation and the details are same as mentioned in semester 5.

Course Outcome:

Upon the successful completion of this course, students will be able to:

1. Students will successfully implement a data science project by applying appropriate methodologies, algorithms, and tools.
2. Students will demonstrate proficiency in data collection, preprocessing, feature engineering, and model development during the project implementation phase.
3. Students will effectively manage project timelines, resources, and deliverables, demonstrating project management skills.
4. Students will collaborate and work effectively in teams, demonstrating teamwork, communication, and coordination skills during project implementation.
5. Students will critically analyse project outcomes, evaluate the effectiveness of their implemented solution, and propose recommendations for future enhancements.

Evaluation Scheme

1. **Internal Evaluation (25 Marks).**
   i. **Test: 1 Class test of 20 marks. (Can be taken online)**

Q	Attempt ***any four*** of the following:	20
a.		
b.		
c.		
d.		
e.		
f.		

   ii. **5 marks: Active participation in the class, overall conduct, attendance.**

2. **External Examination: (75 marks)**

	All questions are compulsory	
Q1	(Based on Unit 1) Attempt ***any three*** of the following:	15
a.		
b.		
c.		
d.		
e.		
f.		
Q2	(Based on Unit 2) Attempt ***any three*** of the following:	15
Q3	(Based on Unit 3) Attempt ***any three*** of the following:	15
Q4	(Based on Unit 4) Attempt ***any three*** of the following:	15
Q5	(Based on Unit 5) Attempt ***any three*** of the following:	15

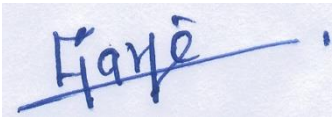
3. **Practical Exam: 50 marks**

   A Certified copy journal is essential to appear for the practical examination.

1.	Practical Question 1	20
2.	Practical Question 2	20
3.	Journal	5
4.	Viva Voce	5

OR

1.	Practical Question	40
2.	Journal	5
3.	Viva Voce	5



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