Syllabus

for the Program of

B.Sc. in Data Science – III

Semester – V and Semester - VI

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
(C B S)

B. Sc. (Data Science)		**Semester – V**	
Course Name : Machine Learning (Paper – I)		Course Code: (5DST01)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
Machine learning techniques enable us to automatically extract features from data so as to solve predictive tasks, such as speech recognition, object recognition, machine translation, question-answering, anomaly detection, medical diagnosis and prognosis, automatic algorithm configuration, personalization, robot control, time series forecasting, and much more.

This course introduces the field of Machine Learning, in particular focusing on the core concepts of supervised and unsupervised learning. Students will learn the algorithms which underpin many popular Machine Learning techniques, as well as developing an understanding of the theoretical relationships between these algorithms.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
3. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
4. Be able to design and implement various machine learning algorithms in a range of real-world applications.

B.Sc. (Data Science)
Semester-5
Paper – I
Machine Learning (5DST01)

UNIT – I

Introduction:

What Is Machine Learning? Examples of Machine Learning Applications

Supervised Learning: Learning a Class from Examples, Vapnik-Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm.

UNIT – II

Parametric Methods: Introduction Maximum Likelihood Estimation, evaluating an Estimator: Bias and Variance, The Bayes' Estimator, Parametric Classification, Regression, Tuning Model Complexity: Bias/Variance Dilemma, Model Selection Procedures, Over fitting and Under fitting.

Multivariate Methods: Multivariate Data, Multivariate Normal Distribution, Multivariate Classification, Discrete Features, Multivariate Regression

Nonparametric Methods: Introduction, Nonparametric Density Estimation, Generalization to Multivariate Data, Nonparametric Classification.

UNIT – III

Dimensionality Reduction: Introduction, Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis, Isomap.

Clustering: Introduction, Mixture Densities, k-Means Clustering, Expectation-Maximization Algorithm, Mixtures of Latent Variable Models, Supervised Learning after Clustering, Hierarchical Clustering, Choosing the number of clusters.

UNIT IV

Kernel Machines:

Introduction, Optimal Separating Hyperplane, The Non-Separable Case: Soft Margin Hyperplane, vSVM, Kernel Trick, Vectorial Kernels, Defining Kernels, Multiple Kernel Learning, Multiclass Kernel Machines, Kernel Machines for Regression,

Text Books:

1. Ethem Alpaydın, Introduction to Machine Learning, PHI, Third Edition, ISBN No. 978-81-203- 5078-6.
2. Nikhil Buduma, Fundamentals of Deep Learning, O'Reilly, First Edition, ISBN No. 978-14-919- 2561-4.
3. Shai shalev-Shwartz and Shai Ben-David, Understanding Machine Learning(From Theory to Algorithms), Cambridge University Press, First Edition, ISBN No. 978-1-107-51282-5.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Mcgraw-Hill, ISBN No. 0- 07-115467-1.
5. Tom Mitchell, Machine Learning, Mcgraw-Hill, First Edition, ISBN No. 0-07-115467-1.
6. Ian Goodfellow and Yoshua Bengio, Deep Learning (Adaptive Computation and machine Learning Series), Massachusetts London, England, ISBN No. 9780262035613.

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
(C B S)

B. Sc. (Data Science)		**Semester – V**	
Course Name : Introduction to Artificial Intelligence (Paper – II)		Course Code: (5DST02)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:

The basic exposition to the goals and methods of Artificial Intelligence along with the applications which involve perception, reasoning and learning and have an understanding of the basic issues of knowledge representation and blind and heuristic search and understanding of some of the more advanced topics of AI such as learning, natural language processing, expert systems, and planning

Learning Outcomes:

After completion of this course successfully the students will be able to:

1. Study the concepts of Artificial Intelligence.
2. Learn the methods of solving problems using Artificial Intelligence.
3. Learn the knowledge representation techniques, reasoning techniques and planning
4. Introduce the concepts of natural language processing

B.Sc. (Data Science)
Semester-5
Paper – II
Introduction to Artificial Intelligence (5DST02)

Unit – I

Introduction to Artificial Intelligence, Background and Applications, Turing Test and Rational Agent approaches to AI, Introduction to Intelligent Agents, their structure, behavior and environment. **Problem Solving:** Problem Characteristics, Production Systems, Control Strategies.

Unit - II

Searching Techniques : Breadth First Search, Depth First Search, Hill climbing and its Variations, Heuristics Search Techniques: Best First Search, A* algorithm, Constraint Satisfaction Problem, Means-End Analysis, Introduction to Game Playing, Min-Max and Alpha-Beta pruning algorithms.

Unit - III

Knowledge Representation:- Representations and mappings, Knowledge Representations, Issues in Knowledge Representation, **Predicate Logic:-** Representing Instance and Isa Relationships, Computable Functions and predicates, Resolution, Natural Deduction, Logc programming, Forward versus Backward Reasoning, Matching, Control knowledge

Unit - IV

Dealing with Uncertainty and Inconsistencies : Truth Maintenance System, Default Reasoning, Probabilistic Reasoning, Bayesian Probabilistic Inference, Possible World Representations. **Understanding Natural Languages :**Parsing Techniques, Context-Free and Transformational Grammars, Recursive and Augmented Transition Nets.

Text Books:

1. DAN.W. Patterson, Introduction to A.I and Expert Systems – PHI, 2007.
2. Russell &Norvig, Artificial Intelligence-A Modern Approach, LPE, Pearson Prentice Hall, 2nd edition, 2005.
3. Rich & Knight, Artificial Intelligence – Tata McGraw Hill, 2nd edition, 1991.
4. Artificial Intelligence by Elaine Rich, Mcgrawhill Inc.
5. Artificial Intelligence and Expert Systems – Jankiraman, Sarukes (M)

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
(C B S)

B. Sc. (Data Science)		**Semester – V**	
Course Name : R-Programming (Paper – III)		Course Code: (5DST03)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
R is rapidly becoming the leading programming language for effective data analysis and statistics. It is the tool of choice for many data science professionals in every industry. The R program delves into intricacies of calculations, co-relations and statistical probabilities and teaches the learners the fundamental understanding of programming with R, detailing all aspects of the language such as understand and process data structures, and mine information through data analysis that can suit a wide variety of purposes, and sectors as varied as finance, defense, health, education, etc. Further, the program dives deeper into the graphical capabilities of R, and helps you create your own stunning data visualizations.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Explain critical R programming concepts
2. Apply OOP concepts in R programming
3. Explain the use of data structure and loop functions
4. Analyze data and generate reports based on the data

B.Sc. (Data Science)
Semester - 5
Paper – III
R-Programming (5DST03)

Unit – I

Getting started with R: R Software: Obtaining R and RStudio, First R Encounter, Getting started: R as a big calculator, Assignment, Working with R, **R Interfaces - Using R and RStudio**: R Software, Obtaining R and RStudio, The default R interface, RStudio Interface, Example Datasets in R, R Packages, Installing new R libraries, Customizing R Start-up **Objects in R:** Using ls and rm to managing R Objects, Types of R objects, Attributes of R Objects, Creating and accessing objects, Modifying elements, **Reading and writing data to and from R:** Importing and reading text, files data into RStudio, Importing data using R command read.table(), Exercise, Importing text files Using scan(), Parsing each line – Readlines, Writing Data table from R, Exercise, Importing Data from other Software, Reading data from Excel into R, Import/Export from other statistical software, From a Database Connection, Sampling and Creating simulated data

Unit – II

Introduction to programming and writing Functions in R: Why do we want to write functions?, Conditional statements (if, ifelse, switch), Repetitive execution: For and While loops, The Apply Functions, Exercise, Functions for parsing text, Programming in R: More advanced, Viewing Code of functions from R packages, Exercise- Parsing Real Data - World Population Data from Wikipedia, Writing functions: more technical discussion -Scoping, Options for Running memory or CPU intensive jobs in R, Efficient R coding **Introduction to graphics in R:** The R function plot(), Exercise, Customize plot with low-level plotting commands, Default parameters – par, Interacting with graphics, Saving plots, Useful Graphics Resources

Unit – III

Advanced Graphics: Advanced plotting using Trellis; ggplots2, Lattice, Examples that Present Panels of Scatterplots using xyplot(), Simple use of xyplot, **Importing Data- readr:** Functions for Reading Data, File Headers, Column Types, String-based Column Type Specification, Function based Column Type Specification Parsing Time and Dates, Space-separated Columns, Functions for Writing Data **Representing Tables – tibble:** Creating Tibbles, Indexing Tibbles **Reformatting Tables – tidyr:** Tidy Data, Gather and Spread, Complex, Column Encodings, Expanding, Crossing, and Completing, Missing Values, Nesting Data

Unit – IV

Pipelines – magrittr : The Problem with Pipelines, Pipeline Notation, Pipelines and Function Arguments, Function Composition, Other Pipe Operations **Working with Strings – stringr:** Counting String Patterns, Splitting Strings, Capitalizing Strings, Wrapping, Padding, and Trimming, Detecting Substrings, Extracting Substrings, Transforming Strings **Working with Factors – forcats**: Creating Factors, Concatenation, Projection, Adding Levels, Reorder Levels **Manipulating Data Frames – dplyr**: Selecting Columns, Filter, Sorting, Modifying Data Frames, Grouping and Summarizing, Joining Tables, Income in Fictional Countries **Working with Dates – lubridate**: Time Points, Time Zones, Time Intervals

Text Books:

1. Introduction to Programming and Statistical Modelling in R Aedin Culhane HARVARD SCHOOL 1st 2013
2. R Data Science Quick Reference Thomas Mailund Apress 1st 2019
3. THE BOOK OF R Tilman M. Davies No starch press 1st 2016
4. Practical Data Science with R NINA ZUMEL JOHN MOUNT MANNING 2014
5. Beginning Data Science in R Thomas Mailund Apress 2017

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
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B. Sc. (Data Science)		**Semester – V**	
Course Name : Big Data Analytics (Paper – IV)		Course Code: (5DST04)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
It aims to equip the learner with a range of most relevant topics that pertain to contemporary analysis practices, and are foundational to the emerging field of big data analytics. Students are guided through the theoretical and practical differences between traditional datasets and Big Data datasets. Students are expected to apply principles of statistical analytics to solve problems and inform decision making. Students achieve this through developing knowledge and understanding of statistical analytics techniques and principles while applying these techniques and principles in typical real world scenarios.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Understand the basic principles of Big Data Analysis, its technologies and challenges.
2. Demonstrate the Big Data technology foundation and how to store data in data ware houses.
3. Understanding analytical approaches and tools to analyze data and develop Big Data Solutions using R
4. Study how data visualization techniques works and about Mobile Analytics tools and challenges

B.Sc. (Data Science)
Semester-5
Paper – IV
Big Data Analytics (5DST04)

Unit – I

Getting an Overview of Big Data: What is Big Data, Evolution of Data management, Structuring Big data, Types of Data, Elements of Big data, Big data Analytics, Advantages of Big data Analytics, Careers and Future of Big data. **Introducing Technologies for Handling Big data:** Distributed and Parallel Computing in Big Data, Introducing Hadoop, HDFS and Map reduce, Cloud computing and big data, Features of Cloud Computing. **Understanding Hadoop Ecosystem:** Hadoop Ecosystem, Hadoop Distributed file system, HDFS Architecture, HDFS Commands, Mapreduce, Hadoop YARN, Introducing HBase, HBase Architecture, Combining HBase and HDFS, Hive, Pig and Pig latin, Sqoop, Zookeeper, Flume, Oozie.

Unit – II

Top Challenges Facing Big Data: Why Big Data Analytics Important; Data Science; Data Scientist; Terminologies used in Big Data Environments; Basically Available Soft State Eventual Consistency (BASE); Open source Analytics Tools **Understanding Big Data Technology Foundation**: Exploring The Big data Stack, Data Source Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Visualization Layer, Big Data Applications, Virtualization and Big Data, Virtualization Approaches

Unit – III

Storing Data In Data Bases and Data Warehouses: RDBMS and Big Data, Issues with Relational Model, Non- Relational Database, Issues with Non-Relational Model, Integrating Big Data with Traditional Data Warehouses. **Understanding Analytics and Big Data**: Comparing Reporting and Analysis, Types of Analytics; Characteristics of Big Data Analytics , Points to Consider during Analysis; Developing an Analytic Team; Understanding Text Analytics; **Approach and Tools to Analyze Data**: Analytical Approaches; History of Analytical Tools; Introducing Popular Analytical Tools; Comparing Various Analytical Tools.

Unit – IV

Data Visualization: Ways of Representing Visual Data, Techniques, Types, Applications, Visualizing Big Data, Tools used in Data Visualization **Social Media Analytics and Text Mining:** Introducing Social Media, Introducing Text Mining, Understanding Text Mining Processes, Sentiment Analysis **Mobile Analytics**: Introducing Mobile Analytics, Define Mobile Analytics, Introducing Mobile Analytics Tools, Performing Mobile Analytics, Challenges of Mobile Analytics.

Reference Books:

1. Big Data (Covers Hadoop 2, Map Reduce, Hive, YARN, Pig, R and Data Visualization) Black Book, DT Editorial Services, Dreamtech Press.
2. Data Science & Big Data Analytics Discovering, Analyzing, Visualizing and Presenting Data EMC Education Services, WILEY Publication
3. Data Science from Scratch Joel Grus O'Reilly 2015
4. BIG DATA and ANALYTICS, Seema Acharya, Subhasinin Chellappan, Wiley publications.
5. Beginners Guide for Data Analysis using R Programming, Jeeva Jose, Khanna Publication.

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B. Sc. (Data Science)		**Semester – V**	
Course Name : Big Data Analytics – Lab		Course Code: (5DSP01)	
Periods per week (1 Period is 120 minutes)		2	
Credits		2	
		Hours	Marks
Evaluation Scheme	Practical Examination	6-8*	50
		Total Marks	50

Big Data Analysis – Lab Practical Based on syllabus contents.

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B. Sc. (Data Science)		**Semester – V**	
Course Name : R- Programming – Lab		Course Code: (5DSP02)	
Periods per week (1 Period is 120 minutes)		2	
Credits		2	
		Hours	Marks
Evaluation Scheme	Practical Examination	6-8*	50
		Total Marks	50

R-Programming – Lab Practical Based on syllabus contents.

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B. Sc. (Data Science)		**Semester – V**	
Course Name : Minor Project		Course Code: (5DSPR01)	
Periods per week (1 Period is 120 minutes)		2	
Credits		2	
		Hours	Marks
Evaluation Scheme	Practical Examination	6-8*	100
		Total Marks	100

Minor Project (5DSPR01) based on Syllabus till 5th Semester

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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Internet of Things (Paper – I)		Course Code: (6DST01)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions. Students will understand the concepts of Internet of Things and can able to build IoT applications.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Understand the various concepts, terminologies and architecture of IoT systems.
2. Use sensors and actuators for design of IoT.
3. Understand and apply various protocols for design of IoT systems
4. Understand various applications of IoT

B.Sc. (Data Science)
Semester- 6
Paper – I
Internet of Things (6DST01)

UNIT I

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures such as four-layer architecture, seven-layer architecture, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.

UNIT II

Sensors Networks : Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, IoT communication protocols: Learning about various communication protocols such as MQTT, CoAP, HTTP, and their usage in IoT devices.

UNIT III

Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT. Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

UNIT IV

Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

Reference Books

1. Internet of Things – A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry
3. INTERNET OF THINGS Architecture and Design Principles, Raj Kamal, McGraw Hill Education (India) Private Limited
4. THE INTERNET OF THINGS KEY APPLICATIONS AND PROTOCOLS Olivier Hersent Actility, France David Boswarthick ETSI, France Omar Elloumi Alcatel-Lucent, France
5. Internet of Things -Architecture, Implementation and Security by Mayur Ramgir
6. Programming Arduino ™ Getting Started with Sketches Simon Monk
7. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE (C B S)

B. Sc. (Data Science)		**Semester – VI**	
Course Name : Optimization Technique (Paper – II)		Course Code: (6DST02)	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students acquire a systematic understanding of optimization techniques, and understand linear optimization in detail with the problem formulation and the solution approaches..

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Explain importance of optimization and Analyze problems in which the objective function and the constraints appear as linear functions of the decision variables

2. Analyze solution of the transportation problem

3. Analyze various methods of solving the unconstrained minimization problem.

4. Understand various methods of solving the constrained problems

B.Sc. (Data Science)
Semester- 6
Paper – II
Optimization Technique (6DST02)

Unit 1

Introduction to Optimization:– Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria – Review of basic calculus concepts – Global optimality

Examples of linear programming problems – formulation simplex methods variable with upper bounds – principle- duality -dual simplex method - sensitivity analysis – revised simplex procedure –

UNIT II

Solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks.

QUEUING THEORY- Queuing Model, poison and exponential distributions -Queues with combined arrivals and departures-random and series queues.

UNIT III

UNCONSTRAINED OPTIMIZATION - Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convegence – unibariate search – steepest and desent methods- metcher reeves method -conjugate gradient method.

UNIT IV

CONSTRAINED OPTIMIZATION - Necessary and sufficient condition – equality constraints, inequality constraints -kuhu – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of sibel directions.

Reference Books

1. Rao S.S,"Optimization – Theory and applications", Wiley Easter Ltd., 1979.
2. S. S. Rao, Engineering Optimisation: Theory and Practice , Wiley, 2008
3. David G.Luerbeggan, "Introduction to Linear and Non Linear Programming", Addison Wesley Publishing Co. 1973.
4. Hadley G. "Nonlinear and – dynamic programming" Addison Wesley Publishing Co. 1964.
5. Cordan C.C. Beveridge and Robert S. Schedther, "Optimization, Theory and Practice" McGraw Hill Co.1970.
6. HarndyA.Tahh. "operations Research, An Introduction", Macmillan Publishers Co.NewYork,1982.
7. Beightferand S. others, "Foundations of Optimization Pill", New Delhi, 1979.

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
(C B S)

B. Sc. (Data Science)		**Semester – VI**	
Course Name : Reinforcement Learning (Paper – III)		Course Code: (6DST03) Elective - I	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students understand Reinforcement Learning(RL) which is a type of machine learning technique that enables an agent to learn in an interactive environment by trial and error using feedback from its own actions and experiences. RL is an autonomous, self-teaching system that essentially learns by trial and error.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Model a control task in the framework of MDPs.
2. Identify the model based from the model free methods.
3. Identify stability/convergence and approximation properties of RL algorithms.
4. Use deep learning methods to RL problems in practice.

B.Sc. (Data Science)
Semester- 6
Paper – III Elective- I
Reinforcement Learning (6DST03)

Unit-1

Introduction. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. **Probability Primer** Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

Unit-2 Markov Decision Process

Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

Unit-3 Prediction and Control by Dynamic Programing

Overiew of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evalutation and value iteration algorithms, DP extensions.

Unit-4 Monte Carlo Methods for Model Free Prediction and Control

Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. **TD Methods** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

Reference Books:

1. Reinforcement Learning: An Introduction Book by Andrew Barto and Richard S. Sutton
2. Deep Reinforcement Learning Hands-On: Apply Modern RL Methods to Practical Problems of Chatbots, Robotics, Discrete Optimization, Web Automation, and More, 2nd Edition Book by Maxim Lapan
3. Foundations of Deep Reinforcement Learning: Theory and Practice in Python Book by Laura Graesser and Wah Loon Keng
4. Hands-On Reinforcement Learning with Python: Master Reinforcement and Deep Reinforcement Learning Using OpenAI Gym and TensorFlow Book by Sudharsan Ravichandiran
5. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems Book by Aurelien Geron

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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Supply Chain and Logistics Analytics (Paper – III)		Course Code: (6DST03) Elective - I	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students understand the Supply chains which typically generate massive amounts of data. Supply chain analytics helps to make sense of all this data — uncovering patterns and generating insights. This means that in order to be successful, firms/organizations need to develop supply chain strategies and logistical capabilities that serve organizations to make intelligent decisions, find undiscovered trends, recognize patterns, unearth untapped potential, and maximize their productivity, and gain a competitive edge by utilizing the power of data.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Understand the importance of the basics of Business Analytics and Optimization
2. Understand the importance of the basics of Supply Chain Analytics and Optimization
3. Analyze the level of uncertainty associated with the supply of products and services to targeted customer segments and justify the choice of a supply chain strategy and its fit with competitive strategy.
4. Explain the role and applications of Prescriptive Analytics in a Supply Chain

B.Sc. (Data Science)
Semester- 6
Paper – III Elective- I
Supply Chain and Logistics Analytics (6DST03)

Unit-1: Context of today's supply chains (SC) analytics Understanding and defining the supply chain analytics (SCA) Revisions of Basic Lessons of Supply Chain Management Why is Analytics Important in a supply chain? Relating Operations Management with Supply chain concepts with SC Analytics The importance of supply chain analytics in the flows involving material, money, information and ownership.

Unit-2 Supply chain analytics Key issues in supply chain analytics What involves in supply chain analytics Concept of Descriptive Analytics in a Supply Chain Discussion on a Case study. Decision Domains in in supply chain analytics

Unit-3 Foundation of Business Analytics (BA)E2: Introduction to Modeling, Approaches for Optimization and Simulation, Modeling software, Supply Chain (SC) Decisions that requires mathematical or interpretative modeling Understanding of Data and its role in Analytics, Analytics of a Transportation problem in a Supply Chain Managerial implication of results of analytics

Unit-4 Foundation of prescriptive analytics in network planning in a supply chain, Network Planning in a Supply Chain Importance of Network Planning Design of Logistics Network using Heuristics/optimization Concept of 3PL/4PL in a Supply Chain Case Study: GATI, DHL

Text Book:-

1. Supply chain management by Sunil Chopra, and Peter Meindl, Pearson Jeremy F. Shapiro. Modeling the Supply Chain. Duxbury Thomson Learning
2. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, Designing and Managing the Supply Chain concepts, Strategies and Case studies, Third Edition, Tata McGraw Hill, zew Delhi, 2008.
3. Rahul Saxena • Anand Srinivasan, Business Analytics

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
(C B S)

B. Sc. (Data Science)		**Semester – VI**	
Course Name : Marketing and Retail Analytics (Paper – III)		Course Code: (6DST03) Elective - I	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students understand, how Data science is now a major part of large retail businesses; it has completely revolutionized how we do business today, and in some cases, the business insights offered by data science have encouraged companies to modernize their workflows, so that various data points can be better tracked. Data science has made a mark on just about every aspect of retail businesses, including marketing strategy, supply chain management The retail supply chain is complex, and many of its key interactions used to be documented with analog mechanisms. But with the influx of new technology, it has become easier to produce raw data that can generate actionable insights for brands in the retail industry.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Explain importance of Segmentation Analytics

2. Analyze solution of the Approaches to Choosing Target Segment/s

3. Understand the concept of Analytics for Product/Service Design:

4. Interpret the Analytics for Tracking Customer Growth

B.Sc. (Data Science)
Semester- 6
Paper – III Elective- I
Marketing and Retail Analytics (6DST03)

Unit-1

Segmentation Analytics: Market Segmentation Variables, Market Segmentation Types, Marketing Data Landscape, Data for Segmentation, Analytics for Need Based Segmentation - Voice of the Customer, Managing "Voice of the Customer" Data, Customer Co-Creation, RFM Analysis, Life Cycle Segmentation, Cross Tabulation Segmentation, Regression based segmentation, Clustering, Conjoint Analysis Segmentation, The Cluster Analysis + Discriminant Analysis Approach,

Unit-2.

Approaches to Choosing Target Segment/s: Rationale for Segment Targeting, Analytics for Perceptual Mapping and Product Positioning, Product Positioning, Multi Dimensional Scaling (MDS) and Factor Analysis, Relevance of Mapping for Product Positioning, Preference Mapping, Incorporating Preferences in Perceptual Mapping.

Unit 3.

Analytics for Product/Service Design: The Relevance of Trade-off Approaches, Conjoint Analysis, Approaches to Conjoint Analysis, Interpreting Conjoint Results, Optimizing Design using Conjoint Results.

Unit-4.

Analytics for Tracking Customer Growth: Rationale for Customer Analytics, Customer acquisition cost, Customer Churn, Customer Attrition models, Customer lifetime value, Net promoter score, Calculating the number of new customers, Calculating average customer age & Days to convert, Calculating customer acquisition cost & Average purchases, Calculating touch points & Lead conversion, Analyzing age demographics, First contact with customer, Customer satisfaction, Understanding customer engagement, Diffusion Models - The Bass Model.

Text Book

1. Marketing Analytics: Data-Driven Techniques with Microsoft Excel, Wayne L. Winston
2. Marketing Analytics: Strategic Models and Metrics, Stephan Sorger
3. Marketing Analytics: A Practical Guide to Improving Consumer Insights Using Data Techniques, Mike Grigsby
4. Cutting-edge Marketing Analytics: Real World Cases and Data Sets for Hands on Learning, Paul Farris, Rajkumar Venkatesan, and Ronald T. Wilcox

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE (C B S)

B. Sc. (Data Science)		**Semester – VI**	
Course Name : Digital Image Processing (Paper – III)		Course Code: (6DST03) Elective - I	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students understand the fundamentals of digital image processing, and various image transforms, image restoration techniques, image compression and segmentation used in digital image processing.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Describe the roles of image processing systems in a variety of applications;
2. Understand the basics of how to manipulate images: enhancement, segmentation, and compression, spatial filtering.
3. Develop Fourier transform for image processing in frequency domain.
4. Evaluate the methodologies for image segmentation, restoration.

B.Sc. (Data Science)
Semester- 6
Paper – III Elective- I
Digital Image Processing (6DST03)

Unit-1:
Introduction: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels- Neighbors and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.

Unit-2:
Image Enhancement In The Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Unit 3:
Image Enhancement In Frequency Domain: Introduction, Fourier Transform, Discrete Fourier Transform (DFT), properties of DFT , Discrete Cosine Transform (DCT), Image filtering in frequency domain. **Image Segmentation:** Introduction, Detection of isolated points, line detection, Edge detection, Edge linking, Region based segmentation- Region growing, split and merge technique, local processing, regional processing, Hough transform, Segmentation using Threshold.

Unit 4:

Image Compression: Introduction, coding Redundancy , Inter-pixel redundancy, image compression model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking, DCT implementation using FFT, Run length coding.

Reference Books:

1. Rafael C G., Woods R E. and Eddins S L, Digital Image Processing, Prentice Hall, 3rd edition, 2008.
2. Milan Sonka,"Image Processing, analysis and Machine Vision", Thomson Press India Ltd, Fourth Edition.
3. Fundamentals of Digital Image Processing- Anil K. Jain, 2nd Edition, Prentice Hall of India.
4. S. Sridhar , Digital Image Processing, Oxford University Press, 2nd Ed, 2016.

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Social Media Analytics (Paper – IV)		Course Code: (6DST04) Elective - II	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students acquire knowledge of Social media analytics and how does it helps to the process of analyzing, measuring and interpreting the data generated from social media platforms and gain insights into consumer behavior, market trends, and customer sentiment. How it helps businesses understand the impact and reach of their social media presence, track engagement and performance of their campaigns, and inform their marketing strategy.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Understand the basics of Social Media Analytics

2. Analyze different web analytic tools

3. Understand the Facebook Analytics.

4. Implement the Python programs to collect and analyze social media data

B.Sc. (Data Science)
Semester- 6
Paper – IV Elective- II
Social Media Analytics (6DST04)

Unit-1 Introduction to Social Media Analytics (SMA): Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas Network fundamentals and models: The social networks perspective - nodes, ties and influencers, Social network and web data and methods. Graphs and Matrices- Basic measures for individuals and networks. Information visualization.

Unit-2 Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity. Web analytics tools: Clickstream analysis, A/B testing, online surveys, Web crawling and Indexing. Natural Language Processing Techniques for Micro-text Analysis.

Unit-3 Facebook Analytics: Introduction, parameters, demographics. Analyzing page audience. Reach and Engagement analysis. Post- performance on FB. Social campaigns. Measuring and Analyzing social campaigns, defining goals and evaluating outcomes, Network Analysis. (LinkedIn, Instagram, YouTube Twitter etc. Google analytics. Introduction. (Websites)

Unit-4 Processing and Visualizing Data, Influence Maximization, Link Prediction, Collective Classification, Applications in Advertising and Game Analytics Introduction to Python Programming, Collecting and analyzing social media data; visualization and exploration

Reference Books:

1 Matthew Ganis, Avinash Kohirkar Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media Pearson 2016
2 Jim Sterne Social Media Metrics: How to Measure and Optimize Your Marketing Investment Wiley Latest edition
3 Oliver Blanchard Social Media ROI: Managing and Measuring Social Que Publishing Latest edition Media Efforts in Your Organization (Que Biz-Tech) .
4 Marshall Sponder Social Media Analytics McGraw Hill Latest edition
5 Tracy L. Tuten, Michael R. Solomon Social Media Marketing Sage Latest edition

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Natural Language Processing (Paper – IV)		Course Code: (6DST04) Elective - II	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students understand, the impact of Natural Language Processing (NLP) in Data Science, on society has been far-reaching and transformative. NLP applications have revolutionized communication, making it more accessible and efficient through chatbots and virtual assistants. Language barriers have been broken down with machine translation systems, fostering cross-cultural understanding and international collaboration.

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Write Python programs to manipulate and analyze language data
2. Understand key concepts from NLP and linguistics to describe and analyze language
3. Understand the data structures and algorithms that are used in NLP
4. Classify texts using machine learning and deep learning

B.Sc. (Data Science)
Semester- 6
Paper – IV Elective- II
Natural Language Processing (6DST04)

Unit-I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language, Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet

Unit-II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings. Categorizing and Tagging Words: Using a Tagger, Tagged Corpora,

Unit-III

Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning

Unit-IV

Extracting Information from Text Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction. Analyzing Sentence Structure Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar

Reference Books

1. Natural Language Processing with Python. Steven Bird, Ewan Klęin, and Edward Lope, O'Reily, 2009
2. Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Akshay Kulkarni, Adarsha Shivananda, Apress, 2019
3. "Foundations of Statistical Natural Language Processing" by Manning & Schí¼tze
4. Natural Language understanding by James Allen, Pearson Education.
5. "Speech and Language Processing" by Jurafsky & Martin
6. Allen James, Natural Language Understanding, Benjamin/Cumming,1995.
7. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Financial Analysis (Paper – IV)		Course Code: (6DST04) Elective - II	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students acquire a systematic understanding how Data science has become an essential tool in financial planning and analysis. The vast amount of data available can be overwhelming to analyze manually. Data science techniques can automate this process, making studying and interpreting financial data easier. By using data science techniques, financial analysts can identify patterns, trends, and outliers in financial data, providing insights that would be challenging to identify using manual analysis. Several data science techniques can be used for financial planning and analysis. In this section, we will explore some of the most popular techniques

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. To understand the basics of Business and financial analytics

2. Analyze solution of regression and different programming models

3. Analyze various methods of decision making techniques

4. Understand various methods of Analytics under Uncertainty

B.Sc. (Data Science)
Semester- 6
Paper – IV Elective- II
Financial Analysis (6DST04)

Unit – I

Introduction to Analytics: Business intelligence, Business Analytics, Managerial spreadsheet analysis and modelling, Applications and Challenges in Business analytics, Marketing and Financial analytics; Organization /sources of data, importance of data quality, dealing with missing or incomplete data, data classification, data presentation/summarization, data mining –process.

Unit II

Predictive Analytics – Simple linear regression, multiple linear regression, logistic and multinomial regression, forecasting techniques; application of predictive analytics in retail, direct marketing, financial services, insurance, supply chain, etc., Optimization Analytics – Multi-period linear programming models and applications, network models and project planning, integer programming and its application in capital budgeting, location decisions, etc.

Unit III

Multi-criteria decision making techniques – goal programming and analytic hierarchy process and applications, Stochastic Analytics – Introduction to stochastic models, Markov models, Renewal theory, Markov decision process and applications in sequential decision making

Unit-IV

Analytics under Uncertainty: Survival analysis and its applications; Six Sigma's a problem solving methodology; Classification and regression trees; lean thinking; dynamic pricing and revenue management; high dimensional data analysis; Analytics in Finance – discounted cash flows, profitability analysis, asset performance measurement tools, introduction to Insurance loss models

Reference Books:

1. Jeanne G. Harris and Thomas H. Davenport, Competing on Analytics: Thenew science of winning, Harvard Business School Press, 2007
2. James Evans, Business Analytics, Pearson, 2012
3. Gert H. N. Laursen, Business Analytics for Managers: Taking Business Intelligence Beyond Reporting, John Wiley & Sons, 2010
4. S. Christian Albright and Wayne L. Winston, Business Analytics: Data Analysis and Decision Making, South-Western College Publishing, 2014

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B. Sc. (Data Science)		**Semester – VI**	
Course Name : Digital Signal Processing (Paper – IV)		Course Code: (6DST04) Elective - II	
Periods per week (1 Period is 60 minutes)		4	
Credits		4	
		Hours	Marks
Evaluation Scheme	Theory Examination	3	80
	Internal Assessment	--	20
		Total Marks	100

Learning Objectives:
The objective of this course is to make students able to understand the fundamental concepts of digital signal processing and Image processing. To explore DFT for 1-D and 2-D signal and FFT for 1-D signal. To apply processing techniques on 1-D and Image signals. And understand the digital image processing techniques for edge detection

Learning Outcomes:
After completion of this course successfully the students will be able to:

1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyze discrete time signals and systems
3. Implement Digital Signal Transform techniques DFT and FFT.
4. Use the enhancement techniques for digital Image Processing

B.Sc. (Data Science)
Semester- 6
Paper – IV Elective- II
Digital Signal Processing (6DST04)

Unit - I

Discrete-Time Signal and Discrete-Time System: Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication) Classification of Discrete-Time Signals, Classification of Discrete Systems Linear Convolution formulation for 1-D and 2-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, LTI system, Concept of Impulse Response and Step Response, Output of DT system using Time Domain Linear Convolution

Unit - II

Discrete Fourier Transform: Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT

Unit - III

Fast Fourier Transform: Need of FFT, Radix-2 DIT-FFT algorithm, DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm. Spectral Analysis using FFT **Digital Image Fundamentals** Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization Representation of Digital Image, Connectivity Image File Formats: BMP, TIFF and JPEG.

Unit - IV

Image Enhancement in Spatial domain: Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Histogram equalization. Neighborhood Processing, Spatial Filtering, Smoothing and Sharpening Filters, Median Filter. **Image Segmentation:** Segmentation based on Discontinuities (point, Line, Edge), Image Edge detection using Robert, Sobel, Previtt masks, Image Edge detection using Laplacian Mask

Reference Books:

1. John G. Proakis, Dimitris and G.Manolakis, _Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, _Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, _Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009,
4. Sanjit Mitra, _Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
5. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, _Digital Signal Processing' Tata McGraw Hill Publication 1st Edition (2010).
6. S. Jayaraman, E. Esakkirajan and T. Veerkumar, _Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
7. Anil K. Jain, _Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

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THREE YEAR BACHELOR OF SCIENCE (B. Sc.) DATA SCIENCE DEGREE COURSE
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B. Sc. (Data Science)		**Semester – VI**
Course Name : Major Project		Course Code: (6DSTPR01)
Periods per week (1 Period is 60 minutes)		4
Credits		4
Evaluation Scheme		
Internal Evaluation		External Evaluation
	Marks	Marks
Two Seminar	40	-
Project Report	60	60
Viva	-	40
Total	100	100

Major project based on the B.Sc. Data Science Syllabus