Academic Council Meeting No. and Date : 08 / September 04, 2023

Agenda Number : 02 **Resolution Number : 34, 35 / 2.20, 2.41**

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme Code: BPDS

Programme : Master of Science

Specific Programme : Data Science

[M.Sc. (Data Science) Part I(Semester I and II)]

Level 6.0

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2023-24

B. N. Bandodkar College of Science (Autonomous), Thane												
Master Program in Data Science												
Year (2 Yrs)	**LEVEL**	**SEMESTER**	**Major**				**Research Methodology**	**On Job Training / Field project**	**Research project**	**Cum Credits**	**Degrees**
			Mandatory			**Electives anyone**					
I	**6.0**	SEM-I	**3*4 + 2 = 14**			Credits 4	**Credits 4**	NA	NA	22	PG Diploma in Environmental Science (After 3 Yrs. degree UG)
			Course 1	Credits 4		Course 1= Credits 4					
			Course 2	Credits 4		**OR**					
			Course 3	Credits 4		Course 2 = Credits 4					
			Course 4	Credits 2		**OR**					
		SEM-II	Course 1	Credits 4		Course 1 = Credits 4	NA	**Credits 4**	NA	**22**	
			Course 2	Credits 4		**OR**					
			Course 3	Credits 4		Course 2 = Credits 4					
			Course 4	Credits 2		**OR**					
Cum Cr. for 1 Yr. PG Diploma			**28**			8	4	4		44	
II	**6.5**	SEM- III	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 4**	22	Master Program in Environmental Science (After 3 Yrs. degree UG)
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
			Course 4	Credits 2	**OR**						
		SEM IV	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 6**	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
					OR						
Cum Cr. for integrated 1 Yr. PG Degree			**26**		**8**				**10**	**44**	
Cum Cr. for 2 Yr. PG Degree			**44**		**16**		**4**	**4**	**10**	**88**	

B. N. Bandodkar College of Science (Autonomous), Thane

Master of Science

Data Science

(To be implemented from the academic year 2023-2024)

SEMESTER I and SEMESTER II

Sr. No.	Heading	Particulars
1.	Title of the Course	M.Sc. (Data Science)
2.	Eligibility for Admission	Students who have Completed B.Sc. with Data Science, Information Technology, Computer Science, Physics, Mathematics, Statistics from recognized University / Board / Institutions. Candidate should have programming background / concepts learned.
3.	Passing Marks	40%
4.	Ordinances / Regulations (if, any)	Existing ordinances and regulations.
5.	Number of years / Semesters	Two years – Four Semesters
6.	Level	PG
7.	Pattern	Semester
8.	To be implemented from Academic year	2023 – 2024
9.	Mode of conduct	Offline / Online Lectures / Practicals

Preamble

Data Science is considered one of the trendiest courses in the world. It leads to the right skills and knowledge required to become a successful Data Analyst or Scientist. Data science is a “concept to unify statistics, data analysis, machine learning and their related methods” in order to “understand and analyze actual phenomena” with data. It’s study of the flow of information from structured and unstructured data available with an organization. It involves obtaining the meaningful insights from the data which is processed through analytical study. One needs to understand the language of data through analytical skill. Hence, it is absolutely necessary nowadays, to develop manpower with a skill to perform data analysis to get meaningful information from the data of different domains such as banking and finance, insurance, agriculture, healthcare, retail, education, social media, manufacturing, transportation, entertainment and so on.

Abhijeet A. Kale
BOS Chairperson

PROGRAMME OUTCOMES (POs) OF MASTERS IN SCIENCE (M.Sc.)

The Postgraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 – Domain Knowledge

Comprehend and demonstrate domain knowledge in specialized branch of science. Instil ability to apply it in upgrading professional, social and personal life.

PO2 – Development of Research Competence

Imbibe skills related to identification of research problem, formulating hypothesis, execution of research process, analysing data, interpreting the data, drawing conclusion and presenting research work. Encourage learners for doctoral studies.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for creating new knowledge resources.

PO4 - Sensitization towards Environment

Build cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Team work

Encourage learner to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 – Competence for Employment

Promote field work, internships, industrial training, research projects, research paper presentations and publications to develop competence for adapting towards dynamic socio-economic changes and make learner employable.

Program Specific Outcome: On completion of the M.Sc. (Information Technology) degree the learners will be able to

1. Explain and apply fundamental concepts of Statistics, Information Technology, and Computer Science essential for problem solving in Data Science. (Level 2)
2. Apply appropriate data visualization and interpretation techniques to analyze datasets and support effective decision-making. (Level 3)
3. Design and develop data-driven solutions demonstrating professional skills required of a Data Scientist in industry, academia, or government sectors.. (Level 6)
4. Formulate and conduct independent research or investigations to solve real-world and practical problems using data science methodologies. (Level 6)
5. Use domain-specific software tools for data storage, processing, analysis, and visualization in data science applications. (Level 3)
6. Integrate qualitative analysis, technical expertise, and professional practices to work effectively in industry and research organizations.. (Level 6)

Credit Distribution Structure for Two Years/ One Year PG / M.Sc. (Data Science)

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Level</th><th rowspan="2">Sem</th><th colspan="4">Major</th><th rowspan="2">RM</th><th rowspan="2">OJT/FP</th><th rowspan="2">RP</th><th rowspan="2">Cum. Cr.</th><th rowspan="2">Degree</th></tr>
<tr><th colspan="3">Mandatory</th><th>Electives</th></tr>
<tr><td rowspan="6">1</td><td rowspan="6">6.0</td><td rowspan="5">Sem I</td><td colspan="3">3*4+1*2</td><td>4</td><td>4</td><td rowspan="5">-</td><td rowspan="5">-</td><td rowspan="5">22</td><td rowspan="11">PG (after 2 Years Degree)</td></tr>
<tr><td>Fundamentals of Data Science</td><td>TH</td><td>4</td><td rowspan="4">Python Programming
(OR)
Java Programming</td><td rowspan="4">4</td></tr>
<tr><td>Databases and Data Warehousing</td><td>TH</td><td>4</td></tr>
<tr><td>Introduction to Data Analysis and Statistical Computing</td><td>TH</td><td>4</td></tr>
<tr><td>Fundamentals of Data Science / Database and Data Warehousing Practicals</td><td>PR</td><td>2</td></tr>
<tr><td rowspan="5">Sem II</td><td colspan="3">3*4+1*2</td><td>4</td><td rowspan="5">-</td><td rowspan="5">4</td><td rowspan="5">-</td><td rowspan="5">22</td></tr>
<tr><td>Big Data Analytics</td><td>TH</td><td>4</td><td rowspan="4">Data Mining
(OR)
Cloud Management</td></tr>
<tr><td>Next Generation Databases</td><td>TH</td><td>4</td></tr>
<tr><td>High Performance Computing</td><td>TH</td><td>4</td></tr>
<tr><td>Next Generation Databases / High Performance Computing Practical</td><td>PR</td><td>2</td></tr>
<tr><td colspan="3">Cum. Cr. For PG Diploma</td><td colspan="3">28</td><td>8</td><td>4</td><td>4</td><td></td><td>44</td></tr>
<tr><td colspan="12">Exit Option: PG Diploma (44 credits) after Three Year UG Degree</td></tr>
</table>

Semester I

VPM's B. N. Bandodkar College of Science (Autonomous), Thane

M.Sc. Data Science

Structure of Programme

SEMESTER I

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
23BPDS1T01	Fundamentals of Data Science	**60**	**4**
23BPDS1T02	Databases and Data Warehousing	**60**	**4**
23BPDS1T03	Introduction to Data Analysis and Statistical Computing	**60**	**4**
23BPDS1P01	Practicals Based on 23BPDS1T01 and 23BPDS1T02	**60**	**2**
ELECTIVE PAPERS			
23BPDS1T04	Python Programming	**30**	**2**
23BPDS1P02	Practicals Based on 23BPDS1T04	**60**	**2**
OR			
23BPDS1T05	JAVA Programming	**30**	**2**
23BPDS1P03	Practicals Based on 23BPDS1T05	**60**	**2**
RESEARCH METHODOLOGY (RM)			
23BPRM1T04	Research Methodology in I.T.	**60**	**4**
	Total Credits		**22**

Course Code	Course Title	Credits	No. of lectures
23BPDS1T01	**Fundamentals of Data Science**	04	60

CO1	Apply quantitative modelling and data analysis techniques to the solution of real-world business problems, communicate findings, and effectively present results using data visualization techniques	L3
CO2	Recognize and analyse ethical issues in business related to intellectual property, data security, integrity, and privacy.	L1
CO3	Describe ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions.	L2
CO4	Demonstrate knowledge of statistical data analysis techniques utilized in business decision making.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	3
CO2	2	2	2	-	1	2
CO3	2	2	1	-	2	3
CO4	3	3	2	-	1	3

Unit I	**INTRODUCTION TO DATA SCIENCE**: Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – introduction to NoSQL.	15 [CO1, CO2]
Unit II	**MODELING METHODS** Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – unsupervised methods	15 [CO1, CO2, CO3]
Unit III	**MAP REDUCE**: Introduction – distributed file system – algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce – Hadoop - Understanding the Map Reduce architecture - Writing Hadoop Map Reduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution	15 [CO3, CO4]
Unit IV	**DELIVERING RESULTS**: Documentation and deployment – producing effective presentations – Introduction to graphical analysis – plot() function – displaying multivariate data – matrix plots – multiple plots in one window - exporting graph - using graphics parameters. Case studies	15 [CO2, CO3, CO4]

References:

1. Practical Data Science by Andreas François Vermeulen APress 2018
2. Principles of Data Science by Sinan Ozdemir PACKT 2016
3. Data Science from Scratch by Joel Grus O'Reilly 2015
4. Data Science from Scratch first Principle in python by Joel Grus Shroff Publishers 2017
5. Experimental Design in Data science with Least Resources by N C Das Shroff Publishers 2018

Course Code 23BPDS1T02	Course Title **Databases and Data Warehousing**	Credits 04	No. of lectures 60

CO1	Identify the correct database management system to solve some real-world problems	L1
CO2	Describe the database and data warehouse design	L2
CO3	Apply OLAP operations for multidimensional data analysis.	L3
CO4	Apply essential terminology in data science to clarify the use of data sources and identify challenges associated with data sources	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	1	3
CO2	3	2	2	-	1	3
CO3	3	3	2	-	1	3
CO4	3	3	3	-	1	3

Unit I	Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Case Studies INTELLIGENT DATABASES Active Databases: Syntax and Semantics (Starburst, Oracle, DB2)- Taxonomy- Applications Design Principles for Active Rules- Temporal Databases: Overview of Temporal Databases TSQL2- Deductive Databases-Recursive Queries in SQL- Spatial Databases- Spatial Data Types	**15** **[CO1, CO4]**
Unit II	XML DATABASES XML Databases: XML Data Model, DTD, XML Schema, XML Querying, Web Databases, Open Database Connectivity. MOBILE DATABASES Mobile Databases: Location and Handoff Management, Effect of Mobility on Data Management, Location Dependent Data Distribution, Mobile Transaction Models, Concurrency Control, Transaction Commit Protocols MULTIMEDIA DATABASES Multidimensional Data Structures, Image Databases, Text / Document Databases, Video Databases, Audio Databases	**15** **[CO1, CO4]**
Unit III	Introduction to Data Warehousing: Introduction, Necessity, Framework of the data warehouse, options, developing data warehouses, end points. Data Warehousing Design Consideration and Dimensional Modeling: Defining Dimensional Model, Granularity of Facts, Additivity of Facts, Functional dependency of the Data, Helper Tables, Implementation many to-many relationships between fact and dimensional modeling.	**15** **[CO2, CO3]**
Unit IV	Data warehousing and OLAP: Defining OLAP, The Value of Multidimensional data, OLAP terminologies, Multidimensional architectures, Multidimensional views of relational data, Physical Multidimensional databases, Data Explosion, Integrated relational OLAP, Data sparsity and data explosion.	**[CO3, CO4]**

References:

1. Database System Concepts by Abraham Silberschatz, Henry Korth McGraw Hill
2. DW2.0 by W.H.Inmon, Derek Strauss Morgan Kaufmann Publication

Course Code 23BPDS1T03	Course Title Introduction to Data Analysis and Statistical Computing	Credits 04	No. of lectures 60

CO1	Explain the fundamental concepts of data analysis and probability theory, including sample spaces, random variables, probability distributions, and their statistical properties.	L2
CO2	Apply appropriate statistical techniques such as regression, correlation, curve fitting, and probability distributions to analyze real-world data sets	L3
CO3	Analyze complex data using advanced statistical models including multiple regression, logistic regression, Poisson regression, survival analysis, and multivariate techniques such as PCA and cluster analysis.	L4
CO4	Implement data analysis workflows using R programming, including data manipulation, visualization, modeling, and interpretation of results for informed decision-making	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	2
CO2	3	3	2	-	1	3
CO3	3	3	2	-	1	3
CO4	3	2	3	-	2	3

Unit I	Introduction: What is Data analysis, importance, future Probability Theory: Sample Spaces, Events, Axioms, Counting, Conditional Probability and Bayes' Theorem, The Binomial Theorem, Random variable and distributions : Mean and Variance of a Random variable-Binomial-Poisson-Exponential and Normal distributions. Curve Fitting and Principles of Least Squares- Regression and correlation.	15 [CO1-CO2]
Unit II	Tabular data, Power and the computation of sample size, Advanced data handling, Multiple regression, Linear models, Logistic regression, Rates and Poisson regression, Nonlinear curve fitting.	15s [CO1-CO2]
Unit III	Density Estimation, Recursive Partitioning, Smoothers and Generalized Additive Models, Survivals Analysis, Analyzing Longitudinal Data, Simultaneous Inference and Multiple Comparisons, Meta Analysis, Principal Component Analysis, Multidimensional Scaling Cluster Analysis.	15 [CO3-CO4]
Unit IV	Introduction to R Packages, Scientific Calculator, Inspecting Variables, Vectors Matrices and Arrays, Lists and Data Frames Functions, Strings and Factors, Flow Control and Loops, Advanced Looping, Date and Times.	15 [CO3-CO4]

References:

1. Statistics by Murray R. Spiegel, Larry J. Stephens. McGRAW –HILL
2. Fundamental of Mathematical Statistics by S.C. Gupta and V.K. Kapoor Sultan Chand and Sons 11th 2011
3. Mathematical Statistics by J.N. Kapur and H.C. Saxena S. Chand 20th Ed 2005

Course Code 23BPDS1P01	Course Title **Fundamentals of Data Science / Database and Data Warehousing Practicals**	Credits 02	No. of lectures 60

CO1	Apply data cleaning, sampling, visualization, and basic statistical techniques using R tools to prepare and explore real-world datasets.	L3
CO2	Analyze datasets using machine learning and statistical models such as clustering, regression, classification, time-series forecasting, and ANOVA to identify patterns and relationships.	L4
CO3	Implement and analyze relational database operations using DDL and DML commands, joins, constraints, views, and relationships to manage structured data effectively.	L3
CO4	Evaluate and develop data-driven solutions through case studies by selecting appropriate data science techniques, interpreting results, and presenting actionable insights	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	1	3
CO2	3	3	2	-	1	3
CO3	3	2	2	-	1	3
CO4	3	3	2	-	2	3

Practical 1	Practical based on Data Cleaning and Sampling using R-Tools
Practical 2	Practical Based on K-Means Clustering using R-Tools
Practical 3	Practical Based on Clustering using R-Tools
Practical 4	Practical Based on Time-series forecasting using R-Tools
Practical 5	Practical Based on Logistics Regression using R-Tools
Practical 6	Practical Based on Analysis of Variance using R-Tools
Practical 7	Practical Based on Decision Tree using R-Tools
Practical 8	Practical Based on Naïve Bayes algorithm using R-Tools
Practical 9	Practical Based on Linear Regression using R-Tools
Practical 10	Practical Based on Data Visualization using R-Tools
Practical 11	Data definition language(DDL)
Practical 12	Data manipulation language(DML)commands in RDBMS
Practical 13	Performing Insertion, Deletion, and Modifying based on conditions.
Practical 14	Performing Altering, Updating and Viewing records based on conditions.
Practical 15	Creating an Student and College data base to set various Join Operations in RDBMS
Practical 16	To create the view, execute and verify the various operations on views.
Practical 17	Creating an Employee database to set various constraints in RDBMS
Practical 18	Creating relationship between the data bases in RDBMS
Practical 19	Case study 1: on Data Science Techniques
Practical 20	Case study 2 : on Data Science Techniques

Course Code	Course Title	Credits	No. of lectures
23BPDS1T04	**Elective I: Python Programming**	02	30

CO1	Explain the fundamental concepts of Python programming, including syntax, data types, operators, control structures, functions, and error types	L2
CO2	Apply Python programming constructs such as conditional statements, loops, functions, and built-in data structures to solve basic computational problems.	L3
CO3	Analyze program behavior using debugging techniques, exception handling, file operations, and recursive functions to identify and correct logical and runtime errors.	L4
CO4	Design and develop modular Python programs using functions, lists, tuples, dictionaries, and file handling to implement efficient and reusable solutions.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	1	2
CO2	3	3	3	-	1	3
CO3	3	2	2	-	1	3
CO4	3	2	3	-	2	3

Unit I	Introduction: The Python Programming Language, History, features, Installing Python, Running Python program, Debugging : Syntax Errors, Runtime Errors, Semantic Errors, Experimental Debugging, Formal and Natural Languages, The Difference Between Brackets, Braces, and Parentheses, Variables and Expressions Values and Types, Variables, Variable Names and Keywords, Type conversion, Operators and Operands, Expressions, Interactive Mode and Script Mode, Order of Operations. Conditional Statements: if, if-else, nested if –else Looping: for, while, nested loops Control statements: Terminating loops, skipping specific conditions Functions: Function Calls, Type Conversion Functions, Math Functions, Composition, Adding New Functions, Definitions and Uses, Flow of Execution, Parameters and Arguments, Variables and Parameters Are Local, Stack Diagrams, Fruitful Functions and Void Functions, Why Functions?Importing with from, Return Values, Incremental Development, Composition, Boolean Functions, More Recursion, Leap of Faith, Checking Types	15 [CO1-CO2]
Unit II	Strings: A String Is a Sequence, Traversal with a for Loop, String Slices, Strings Are Immutable, Searching, Looping and Counting, String Methods, The in Operator, String Comparison, String Operations Lists: Values and Accessing Elements, Lists are mutable, traversing a List, Deleting elements from List, Built-in List Operators, Concatenation, Repetition, In Operator, Built-in List functions and methods Tuples and Dictionaries: Tuples, Accessing values in Tuples, Tuple Assignment, Tuples as return values, Variable-length argument tuples, Basic tuples operations, Concatenation, Repetition, in Operator, Iteration, Built-in Tuple Functions Creating a Dictionary, Accessing Values in a dictionary, Updating Dictionary, Deleting Elements from Dictionary, Properties of Dictionary keys, Operations in Dictionary, Built-In Dictionary Functions, Built-in Dictionary Methods Files: Text Files, The File Object Attributes, Directories Exceptions: Built-in Exceptions, Handling Exceptions, Exception with Arguments	15 [CO3-CO4]

References:

1. An Introduction to Computer Science using Python 3 by Jason Montojo, Jennifer Campbell, Paul Gries, SPD 1st 2014
2. Introduction to Problem Solving with Python by E. Balagurusamy TMH 1st 2016
3. Murach's Python programming by Joel Murach, Michael Urban SPD 1st 2017
4. Object-oriented Programming in Python by Michael H. Goldwasser, David Letscher Pearson Prentice Hall 1st 2008
5. Exploring Python by Budd TMH 1st 2016

Course Code	Course Title	Credits	No. of lectures
23BPDS1P02	**Python Programming Practicals**	**02**	**60**

CO1	Apply Python programming constructs including operators, conditional statements, loops, and functions to solve basic computational problems and perform simple calculations.	L3
CO2	Analyze data structures such as lists and dictionaries to manipulate, sort, search, and process elements effectively.	L4
CO3	Evaluate program behavior and string-based problems, including checking for palindromes, pangrams, Armstrong numbers, and performing recursive computations such as factorial and Fibonacci series.	L5
CO4	Design and develop Python programs involving file operations, text processing, and combining multiple data structures to implement efficient, reusable, and modular solutions.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	1	3
CO2	3	2	3	-	1	3
CO3	3	3	2	-	1	3
CO4	3	2	3	-	2	3

Practical 1	Write a Python program to show Simple Calculation Operations with various operators.
Practical 2	Create a program that asks the user to enter their name and their age. Print out a message addressed to them that tells them the year that they will turn 100 years old.
Practical 3	Enter the number from the user and depending on whether the number is even or odd, print out an appropriate message to the user.
Practical 4	Write a program to generate the Fibonacci series.
Practical 5	Write a function that reverses the user defined value.
Practical 6	Write a function to check the input value is Armstrong and also write the function for Palindrome.
Practical 7	Write a recursive function to print the factorial for a given number.
Practical 8	Write a function that takes a character (i.e. a string of length 1) and returns True if it is a vowel, False otherwise.
Practical 9	Define a function that computes the length of a given list or string.
Practical 10	A pangram is a sentence that contains all the letters of the English alphabet at least once, for example: The quick brown fox jumps over the lazy dog. Your task here is to write a function to check a sentence to see if it is a pangram or not.
Practical 11	Take a list, say for example this one: a=[1,1,2,3,5,8,13,21,34,55,89] and write a program that prints out all the elements of the list that are less than 5.
Practical 12	Write a program that takes two lists and returns True if they have at least one common member.
Practical 13	Write a Python program to print a specified list after removing the 0th, 2nd, 4th and 5th elements.
Practical 14	Write a Python program to clone or copy a list
Practical 15	Write a Python script to sort (ascending and descending) a dictionary by value.
Practical 16	Write a Python script to concatenate following dictionaries to create a new one.
Practical 17	Write a Python program to sum all the items in a dictionary.
Practical 18	Write a Python program to read an entire text file.
Practical 19	Write a Python program to append text to a file and display the text.
Practical 20	Write a Python program to read last n lines of a file.

Course Code 23BPDS1T05	Course Title **Elective II: JAVA Programming**	Credits 02	No. of lectures 30

CO1	Explain the fundamental concepts of Java programming, including syntax, data types, arrays, operators, object-oriented programming principles, and exception handling.	L2
CO2	Apply object-oriented programming concepts such as classes, objects, inheritance, polymorphism, abstraction, and encapsulation to develop modular Java programs.	L3
CO3	Analyze advanced Java features including multithreading, networking, wrapper classes, collections, inner classes, and string manipulations to solve real-world programming problems.	L4
CO4	Design and implement Java-based GUI applications using AWT, event-handling, and listeners, integrating core and advanced Java features to build functional and reusable software solutions.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	1	2
CO2	3	2	2	-	1	3
CO3	3	3	2	-	1	3
CO4	3	2	3	-	2	3

Unit I	**The Java Language:** Features of Java, Java programming format, Java Tokens,Java Statements, Java Data Types, Typecasting, Arrays **OOPS:** Introduction, Class, Object, Static Keywords, Constructors, this Key Word, Inheritance, super Key Word, Polymorphism (overloading and overriding), Abstraction, Encapsulation, Abstract Classes, Interfaces **String Manipulations:** String, String Buffer, String Tokenizer **Packages:** Introduction to predefined packages (java.lang, java.util, java.io,java.sql, java.swing), User Defined Packages, Access specifiers **Exception Handling:** Introduction, Pre-Defined Exceptions, Try-CatchFinally, Throws, throw, User Defined Exception examples **Multithreading:** Thread Creations, Thread Life Cycle, Life Cycle Methods,Synchronization, Wait() notify() notify all() methods	15 [CO1-CO2]
Unit II	**Networking:** Introduction, Socket, Server socket, Client – Server Communication **Wrapper Classes:** Introduction, Byte, Short, Integer, Long, Float, Double, Character, Boolean classes **Collection Framework:** Introduction, util Package interfaces, List, Set, Map,List interface & its classes, Set interface & its classes, Map interface & its classes **Inner Classes:** Introduction, Member inner class, Static inner class, Local inner class, Anonymous inner class **AWT:** Introduction, Components, Event-Delegation-Model, Listeners, Layouts, Individual components Label, Button, CheckBox, Radio Button, Choice, List, Menu, Text Field, Text Area	15 [CO3-CO4]

References:

1. Java The Complete Reference by Herbert Schildt McGraw-Hill Education, Ninth Edition 2014
2. Programming with Java by E. Balagurusamy McGraw-Hill Education 2014
3. Programming in JAVA by Sachin Malhotra, Oxford Press 2nd Ed

Course Code 23BPIT1P03	Course Title Elective II: JAVA Programming Practical	Credits 02	No. of lectures 60

CO1	Apply Java programming constructs including operators, data types, control statements, loops, and exception handling to solve computational and logical problems.	L3
CO2	Analyze object-oriented programming concepts such as inheritance, method overloading, and method overriding to implement modular and reusable Java programs.	L4
CO3	Evaluate Java data structures such as lists and arrays to perform operations including sorting, addition, and manipulation for real-world problem solving	L5
CO4	Design and develop interactive GUI applications using Java AWT components, including calculators and dynamic window interfaces, integrating core Java features to build functional programs	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	1	3
CO2	3	2	2	-	1	3
CO3	3	2	3	-	1	3
CO4	3	2	3	-	2	3

Practical 1	Practical Based on Java Operators
Practical 2	Practical Based on Java Data Types
Practical 3	Practical Based on Java Various Statements
Practical 4	Practical Based on Looping Statements.
Practical 5	Practical Based on Break and Continue Keyword
Practical 6	Practical Based on various exception.
Practical 7	Accept the coefficients of quadratic equation. Find the solution of quadratic equation.
Practical 8	Accept two n x m matrices. Write a Java program to find addition of these matrices.
Practical 9	Accept n strings. Sort names in ascending order.
Practical 10	Demonstrate Java inheritance using extends keyword.
Practical 11	Demonstrate method overriding in Java.
Practical 12	Demonstrate method overloading in Java.
Practical 13	Write a Java List example and demonstrate methods of Java List interface.
Practical 14	Design simple calculator GUI application using AWT components.
Practical 15	Design simple GUI application using AWT components to change background color of window with clicking of respective color button

Course Code	Course Title	Credits	No. of lectures
23BPRM1T07	**Research Methodology**	**04**	**60**

CO1	Explain the fundamental concepts of business research, information systems, knowledge management, theory building, and ethical considerations in organizational research.	L2
CO2	Apply qualitative and quantitative research methods, including problem definition, survey design, observation, and experimental techniques, to collect reliable primary and secondary data.	L3
CO3	Analyze measurement concepts, sampling techniques, questionnaire design, and fieldwork procedures to ensure valid and representative data collection.	L4
CO4	Evaluate and interpret univariate, bivariate, and multivariate statistical analyses to draw meaningful conclusions and present research findings effectively for business decision-making.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	2
CO2	3	3	2	-	2	3
CO3	3	3	2	-	2	3
CO4	3	3	2	-	2	3

Unit I	Introduction: Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and Issues Beginning Stages of Research Process: Problem definition, Qualitative research tools, Secondary data research	**15 [CO1-CO2]**
Unit II	Research Methods and Data Collection: Survey research, communicating with respondents, Observation methods, Experimental research	**15 [CO1-CO3]**
Unit III	Measurement Concepts, Sampling and Field work: Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size	**15 [CO2-CO3]**
Unit IV	Data Analysis and Presentation: Editing and Coding, Basic Data Analysis, Univariate Statistical Analysis and Bivariate Statistical analysis and differences between two variables. Multivariate Statistical Analysis	**15 [CO3-CO4]**

References:

1. Business Research Methods by William G.Zikmund, B.J Babin, J.C. Carr, Atanu Adhikari, M.Griffin Cengage 8e 2016
2. Business Analytics by Albright Winston Cengage 5e 2015
3. Research Methods for Business Students by Mark Saunders Fifth Edition 2011
4. Multivariate Data Analysis Hair Pearson 7e 2014

Semester II

SEMESTER II

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
23BPDS2T01	Big Data Analytics	60	4
23BPDS2T02	Next Generation Databases	60	4
23BPDS2T03	High Performance Computing	60	4
23BPSD2P01	Practicals Based on 23BPDS2T02 and 23BPDS2T03	60	2
ELECTIVE PAPERS			
23BPDS2T04	Data Mining	30	2
23BPDS2P02	Practicals Based on 23BPDS2T04	60	2
OR			
23BPDS2T05	Cloud Management	30	2
23BPDS2P03	Practicals Based on 23BPDS2T05	60	2
ON-JOB TRAINING (OJT) / FIELD PROJECT (FP)			
23BPDS2P04	ON-JOB TRAINING (OJT) / FIELD PROJECT (FP) in Data Science	120	4
Total Credits			**22**
Total Semester I & Semester II Credits			**44**

Course Code	Course Title	Credits	No. of lectures
23BPDS2T01	**Big Data Analytics**	**04**	**60**

CO1	Explain the fundamental concepts of Big Data, its characteristics, evolution, challenges, and the differences between traditional business intelligence and modern Big Data analytics ecosystems.	L2
CO2	Apply analytical techniques including clustering, association rules, regression, classification, and time series methods to structured and unstructured datasets for extracting actionable insights.	L3
CO3	Analyze text data using methods such as TF-IDF, sentiment analysis, and topic categorization, and evaluate the performance of different analytical algorithms and models.	L4
CO4	Design and implement scalable data products using Hadoop, Spark, MapReduce, and associated Big Data tools, including distributed storage, in-memory computing, and higher-level APIs, to solve real-world data-intensive problems.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	1	2
CO2	3	3	2	-	2	3
CO3	3	3	3	-	2	3
CO4	3	3	3	-	2	3

Unit I	• Introduction to Big Data, Characteristics of Data, and Big Data Evolution of Big Data, Definition of Big Data, Challenges with big data, Why Big data? Data Warehouse environment, Traditional Business Intelligence versus Big Data. State of Practice in Analytics, Key roles for New Big Data Ecosystems, Examples of big Data Analytics. • Big Data Analytics, Introduction to big data analytics, Classification of Analytics, Challenges of Big Data, Importance of Big Data, Big Data Technologies, Data Science, Responsibilities, Soft state eventual consistency. Data Analytics Life Cycle	**15 [CO11-CO2]**
Unit II	• Analytical Theory and Methods: Clustering and Associated Algorithms, Association Rules, Apriori Algorithm, Candidate Rules, Applications of Association Rules, Validation and Testing, Diagnostics, Regression, Linear Regression, Logistic Regression, Additional Regression Models. • Analytical Theory and Methods: Classification, Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods, Time Series Analysis, Box Jenkins methodology, ARIMA Model, Additional methods. Text Analysis, Steps, Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments	**15 [CO3-CO4]**
Unit III	• Data Product, Building Data Products at Scale with Hadoop, Data Science Pipeline and Hadoop Ecosystem, Operating System for Big Data, Concepts, Hadoop Architecture, Working with Distributed file system, Working with Distributed Computation, • Framework for Python and Hadoop Streaming, Hadoop Streaming, MapReduce with Python, Advanced MapReduce. In-Memory Computing with Spark, Spark	**15 [CO1-CO3]**

	Basics, Interactive Spark with PySpark, Writing Spark Applications	
Unit IV	• Distributed Analysis and Patterns, Computing with Keys, Design Patterns, Last-Mile Analytics, Data Mining and Warehousing, Structured Data Queries with Hive, HBase, Data Ingestion • Importing Relational data with Sqoop, Injesting stream data with flume. Analytics with higher level APIs, Pig, Spark's higher level APIs	**15 [CO3, CO4]**

References:

1. Big Data and Analytics by Subhashini Chellappan Seema Acharya Wiley First
2. Data Analytics with Hadoop An Introduction for Data Scientists by Benjamin Bengfort and Jenny Kim O'Reilly 2016
3. Big Data and Hadoop by V.K Jain Khanna Publishing First 2018

Course Code	Course Title	Credits	No. of lectures
23BPDS2T02	**Next Generation Databases**	**04**	**60**

CO1	Remember and describe the fundamental concepts of NoSQL databases, ACID vs. BASE, CAP theorem, and differences between SQL and NoSQL databases.	L1
CO2	Explain and interpret MongoDB architecture, data models (JSON/BSON), collections, documents, and querying operations using the MongoDB shell.	L2
CO3	Evaluate and apply appropriate database design strategies, indexing, and aggregation operations in MongoDB for efficient data storage and retrieval in real-world scenarios.	L5
CO4	Design and develop interactive web applications integrating NoSQL databases, in-memory databases, and client-side scripting using jQuery for dynamic content and improved user experience.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	-	-	1
CO2	2	2	3	-	1	2
CO3	2	2	3	-	2	3
CO4	2	1	3	-	3	3

Unit I	**NoSQL:** SQL, NoSQL, Definition, A Brief History of NoSQL, ACID vs. BASE, CAP Theorem (Brewer‟s Theorem), The BASE, NoSQL Advantages and Disadvantages, Advantages of NoSQL, Disadvantages of NoSQL, SQL vs. NoSQL Databases, Categories of NoSQL Databases	15 [CO1, CO2]
Unit II	**Introducing MongoDB**: History, MongoDB Design Philosophy, Speed, Scalability, and Agility, Non-Relational Approach, JSON-Based Document Store, Performance vs. Features, Running the Database Anywhere, SQL Comparison **The MongoDB Data Model**: The Data Model, JSON and BSON, The Identifier (_id),Capped Collection, Polymorphic Schemas, Object Oriented Programming, Schema Evolution	15 [CO2, CO3]
Unit III	**Using MongoDB Shell** : Basic Querying, Create and Insert, Explicitly Creating Collections, Inserting Documents Using Loop, Inserting by Explicitly Specifying _id,Update, Delete, Read, Using Indexes, Stepping Beyond the Basics, Using Conditional Operators, Regular Expressions, MapReduce, aggregate(),Designing an Applications Data Model, Relational Data Modeling and Normalization, MongoDB Document Data Model Approach	15 [CO2, CO4]
Unit IV	SSD and In-Memory Databases: End of Disk, Solid State Disk, The Economics of Disk, SSD-Enabled Databases, In-Memory Databases, TimesTen, Redis, **jQuery:** Introduction, Traversing the DOM, DOM Manipulation with jQuery, Events, Ajax with jQuery, jQuery Plug-ins, jQuery Image Slider	15 [CO3, CO4]

References:

1. Next Generation Database: NoSQL and big data by Guy Harrison Apress
2. Practical MongoDB by Shakuntala Gupta Edward NavinSabharwal Apress
3. Beginning jQuery by Jack Franklin Russ Ferguson Apress

Course Code	Course Title	Credits	No. of lectures
23BPDS2T03	**High Performance Computing**	**04**	**60**

CO1	Recall and describe fundamental concepts of graph algorithms, including minimum spanning trees, shortest path algorithms, and search techniques for discrete optimization problems.	L1
CO2	Explain and apply parallel computing concepts such as message passing, MPI communication, synchronization, and domain decomposition to solve computational problems efficiently.	L2
CO3	Analyze and implement neural network architectures, including convolutional and recurrent neural networks, for solving real-world problems in healthcare, banking, and financial services domains.	L3
CO4	Evaluate the performance and scalability of graph and parallel algorithms and critically assess analytics techniques in domain-specific applications such as provider analytics, risk analytics, and engagement analytics.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	1	2
CO2	3	2	3	-	2	3
CO3	3	2	3	-	2	3
CO4	3	3	2	-	2	3

Unit I	Graph Algorithms, Minimum Spanning Tree, Prim's Algorithm, Single, Source Shortest Paths, Dijkstra's Algorithm, All-Pairs Shortest Paths, Algorithms for Sparse Graphs, Search Algorithms for Discrete Optimization, Problems, Sequential Search Algorithms, Parallel Depth, First Search, Parallel Breadth, First Search	15 [CO1]
Unit II	Message passing, MPI example, Messages and point-to-point communication, Collective communication, Non blocking point-to-point communication, Virtual topologies, Example, MPI parallelization of Jacobi solver, Communication parameters	15 [CO1-CO2]
Unit III	Synchronization serialization, contention, Implicit serialization and synchronization Contention, Reducing communication overhead, Optimal domain decomposition, Aggregating messages, Non blocking vs. asynchronous communication	15 [CO2, CO3]
Unit IV	**Neural Networks**: Introduction to Neural Networks, Convultional Neural Networks, Recurrent Neural Networks **Healthcare** : Understanding the Healthcare Domain, Provider Analytics, Payer Analytics, Analytics in the Pharmaceutical Industries **Banking and Financial Services** : Introduction to Banking and Financial Services, Acquisition Analytics, Engagement Analytics, Risk Analytics	15 [CO3, CO4]

References:

1. Parallel and High Performance Computing Robert Robey, Zamora Yuliana Manning
2. High Performance Cluster Computing: Architectures and Systems, Rajkumar Pearson Education
3. High Performance Computing for Big Data Methodologies and Application Chao Wang CRC Press

Course Code 23BPDS2P01	Course Title Practicals based on 23BPDS2T02 and 23BPDS2T03	Credits 02	No. of lectures 60

CO1	Apply MongoDB commands and queries to create, manipulate, and manage databases and collections, perform CRUD operations, and implement aggregate functions for real-world data storage and retrieval.	L3
CO2	Implement jQuery techniques including selectors, events, effects, animations, content manipulation, and chaining to develop dynamic and interactive web pages.	L3
CO3	Analyze and implement fundamental graph and search algorithms such as Prim's algorithm, linear search, DFS, BFS, Dijkstra's shortest path, and divide-and-conquer strategies to solve computational problems efficiently.	L4
CO4	Evaluate and design neural network models, including convolutional neural networks and regularization techniques, to solve real-world classification and prediction problems while optimizing model performance and minimizing overfitting.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	2	3
CO2	2	1	3	-	3	2
CO3	3	2	2	-	3	3
CO4	3	3	2	-	2	3

Practical 1	Write a MongoDB query to create and drop database.
Practical 2	Write a MongoDB query to create, display and drop collection
Practical 3	Write a MongoDB query to insert, query, update and delete a document.
Practical 4	Simple Queries with MongoDB
Practical 5	Write a MongoDB query to use sum, avg, min and max expression.
Practical 6	Write a MongoDB query to use push and addToSetexpression.
Practical 7	Write a MongoDB query to use first and last expression.
Practical 8	Connecting Python with MongoDB and inserting, retrieving, updating and deleting.
Practical 9	jQuery Basic, jQuery Events
Practical 10	jQuery Selectors, jQuery Hide and Show effects
Practical 11	jQuery fading effects, jQuery Sliding effects
Practical 12	jQuery Animation effects, jQuery Chaining
Practical 13	jQuery Callback, jQuery Get and Set Contents
Practical 14	jQuery Insert Content, jQuery Remove Elements and Attribute
Practical 15	Write a program to implement prim's algorithm using C/C++/Python/Java/C# language.
Practical 16	Write a program to implement linear search using C/C++/Python/Java/C# language.
Practical 17	Write program to implement Divide and Concur algorithm usingC/C++/Python/Java/C# language.
Practical 18	Write a program to implement DFS algorithm using C/C++/Python/Java/C#language.
Practical 19	Write a program to implement BFS algorithm using C/C++/Python/Java/C#language.
Practical 20	Write program to implement Dijkstra's shortest path algorithm using C/C++/Python/Java/C#
Practical 21	Implementation of convolutional neural network to predict numbers
Practical 22	Implementing regularization to avoid overfitting in binaryclassification.

Course Code 23BPDS2T04	Course Title **Elective I : Data Mining**	Credits 02	No. of lectures 30

CO1	Recall and describe the fundamental concepts of data mining, data types, knowledge representation schemes, and related techniques.	L1
CO2	Apply data mining methods to mine frequent patterns, associations, and correlations, and analyze datasets to extract meaningful insights.	L3
CO3	Evaluate complex data types including graph, social network, spatial, multimedia, text, and web data using appropriate mining techniques and justify the selection of methods	L5
CO4	Design and develop novel data mining solutions for multidimensional and multirelational datasets, integrating various mining approaches for real-world problem solving.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	1
CO2	3	2	3	1	2	2
CO3	2	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Introduction:** Basics of data mining, related concepts, Data mining techniques. **Data:** Introduction, Attributes, Data Sets, and Data Storage, Issues Concerning the Amount and Quality of Data, **Knowledge Representation:** Data Representation and their Categories: General Insights, Categories of Knowledge Representation, Granularity of Data and Knowledge Representation Schemes, Sets and Interval Analysis, Fuzzy Sets as Human-Centric Information Granules, Shadowed Sets, Rough Sets, Characterization of Knowledge Representation Schemes, Levels of Granularity and Perception Perspectives, The Concept of Granularity in Rules.	15 [CO1-CO2]
Unit II	**Mining Frequent Patterns, Associations, and Correlations:** Basic Concepts, Efficient and Scalable Frequent Item set Mining Methods, Mining Various Kinds of Association Rules, From Association Mining to Correlation Analysis, Constraint-Based Association Mining **Graph Mining, Social Network Analysis, and Multirelational Data Mining:** Graph Mining, Social Network Analysis, Multirelational Data Mining. **Mining Object, Spatial, Multimedia, Text, and Web Data:** Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.	15 [CO3-CO4]

References:

1. Data Mining: Introductory and Advanced Topics by M. H. Dunham Pearson Education 2010
2. Data Mining A Knowledge Discovery Approach" by Krzysztof J. Cios, W. Pedrycz,R. W. Swiniarski, L.A. Kurgan Springer
3. Data Mining: Concepts and Techniques by J. Han and M. Kamber, Elsevier 2nd 2008
4. Principles of Data Mining D. Hand, H. Mannila and P. Smyth Prentice-Hall 2001
5. Data Mining with SQL Server 2005 Z.Tang and J MacLennan, Wiley

Course Code 23BPDS2P02	Course Title Elective I : Data Mining Practical	Credits 02	No. of lectures 60

CO1	Analyze datasets using Python and WEKA tools by performing data cleaning, sampling, and preprocessing to prepare data for mining and predictive modeling.	L4
CO2	Evaluate the performance of machine learning algorithms such as K-Means, clustering techniques, logistic regression, decision trees, and Naïve Bayes to select most suitable model for real-world data.	L5
CO3	Critically assess predictive models, including linear regression, time-series forecasting, and ANOVA, to validate results and ensure accurate interpretation of outcomes.	L5
CO4	Design and implement comprehensive data analysis solutions integrating Python and WEKA tools for visualization, modeling, and decision-making in practical, real-world problem scenarios.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	2	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

Practical 1	Practical based on Data Cleaning and Sampling using python and WEKA Tool.
Practical 2	Practical Based on K-Means Clustering using python and WEKA Tool.
Practical 3	Practical Based on Clusteringusing python and WEKA Tool.
Practical 4	Practical Based on Time-series forecastingusing python and WEKA Tool.
Practical 5	Practical Based on Logistics Regressionusing python and WEKA Tool.
Practical 6	Practical Based on Analysis of Varianceusing python and WEKA Tool.
Practical 7	Practical Based on Decision Treeusing python and WEKA Tool.
Practical 8	Practical Based on Naïve Bayes algorithm using python and WEKA Tool.
Practical 9	Practical Based on Linear Regressionusing python and WEKA Tool.
Practical 10	Practical Based on Data Visualization using python and WEKA Tool.

Course Code 23BPDS2T05	Course Title **Elective II: Cloud Management**	Credits 02	No. of lectures 30

CO1	Recall and describe the fundamental concepts of virtualized data center architectures, cloud infrastructures (public, private, hybrid), and service models (SaaS, PaaS, IaaS), including business continuity and disaster recovery principles.	L1
CO2	Explain and interpret the design, planning, and management of virtualized data center environments and cloud infrastructures, including provisioning and self-service capabilities using tools like AppController and VMM 2012.	L2
CO3	Apply cloud and virtualized data center management techniques using System Center 2012, Configuration Manager, and Data Protection Manager for deployment, administration, backup, and recovery of cloud resources.	L3
CO4	Implement strategies for managing private, public, and hybrid cloud environments by configuring, monitoring, and maintaining virtual machines, applications, and cloud services efficiently.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	1
CO2	3	2	3	1	2	2
CO3	2	2	3	1	2	3
CO4	2	2	3	1	3	3

Unit I	Virtualized Data Center Architecture: Cloud infrastructures; public, private, hybrid. Service provider interfaces; Saas, Paas, Iaas. VDC environments; concept, planning and design, business continuity and disaster recovery principles. Managing VDC and cloud environments and infrastructures Cloud Management: System Center 2012 and Cloud OS, Provisioning Infrastructure: Provisioning Infrastructure with Virtual Machine Designing, Planning and Implementing.	15 [CO1, CO2]
Unit II	Managing Hyper-V Environment with VMM 2012. Provisioning self-service with AppController, AppController essentials, Managing Private, Public, Hybrid clouds. AppControllercmdlets. Managing and maintaining with Configuration Manager 2012, Design, Planning, Implementation, Administration, Distributing Applications, Updates, Deploying Operating Systems, Asset Management and reporting. Backup and recovery with Data Protection Manager. Design, Planning, Implementation and Administration.	15 [CO3, CO4]

References:

1. Introducing Microsoft System Center2012, Technical Overview by Mitch Tulloch, Symon Perriman and Symon Perriman Microsoft
2. Microsft System Center 2012 Unleashed by Chris Amaris, Randorimoto, Pete Handley, David E. Ross,Technical Editby Yardeni Pearson Education
3. Automating vSphere with Mware vCenter Orchestrator

Course Code 23BPDS2P03	Course Title Elective II: Cloud Management Practical	Credits 02	No. of lectures 60

CO1	Recall and describe the fundamental components of SCVMM 2019, App-Controller, Data Protection Manager, and Configuration Manager, including their roles in managing Hyper-V environments, cloud provisioning, and device management.	L1
CO2	Apply SCVMM 2019 and App-Controller functionalities to configure, provision, and manage private cloud services, perform backup and recovery operations, and implement self-service capabilities in practical cloud scenarios.	L3
CO3	Evaluate the performance and efficiency of orchestrated cloud management workflows, including runbook execution, throttling, and database recovery, to ensure optimal deployment and management of virtualized environments.	L5
CO4	Design, implement, and optimize complete cloud solutions using SCVMM 2019, Configuration Manager, and Orchestrator by integrating site hierarchies, replication strategies, and device management for real-world enterprise scenarios.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	2
CO2	2	2	3	1	2	3
CO3	2	2	3	1	2	3
CO4	3	2	3	1	3	3

Practical 1	Managing Hyper-V environment with SCVMM 2019
Practical 2	Provisioning Self-Service using App-Controllerwith SCVMM 2019
Practical 3	Managing Private cloud using App-Controller with SCVMM 2019
Practical 4	Using Data Protection for Backup and Recovery with SCVMM 2019
Practical 5	Create and Manage Cloud using SCVMM 2019
Practical 6	Deploy Service Manager using with SCVMM 2019
Practical 7	Install Orchestrator, Create and test a monitor runbook, Manage Orchestrator Servers – 1, Runbook permissions, Back up Orchestrator, Bench mark , Optimize performance of .Net activities, Configure runbook throttling, Recover a databasewith SCVMM 2019
Practical 8	Managing devices with Configuration Manager, Design a hierarchy of sites using Microsoft End Point Configuration manager, Data transfers between sites, Types of data transfer, File-based replication, Database replication with SCVMM 2019

Course Code 23BPDS2P04	Course Title ON-JOB TRAINING/RESEARCH PROJECT IN Data Science	Credits 04	No. of hours 120

CO1	Apply theoretical knowledge in real workplace situations	
CO2	Demonstrate professional workplace skills and ethics	
CO3	Use industry tools, technologies, and procedures competently	
CO4	Evaluate work performance and identify areas for improvement	

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	3	3
CO2	2	1	2	2	3	3
CO3	3	2	3	1	2	3
CO4	2	3	2	1	3	3

General Guidelines:

- The OJT/FP topic may be undertaken from any topic relevant to course
- Each of the learners must undertake an OJT/FP individually based on field-work/field-survey/laboratory work.
- Learners must remain presented at the time of review meeting scheduled by research guide.
- Structure of report should contain the following chapter: Title; Abstract; Aim, Objectives, and Rationale; Introduction and Review of Literature; Materials and Methodology; Observation and Result; Discussion and Conclusion; References.
- Learners should prepare a PowerPoint presentation (PPT) of research project and it should be presented in front of external examiner.
- Duly signed hard copy of report and PPT should be submitted to the Department
- In case of OJT, detail report of attendance, record and acknowledgement /certificate issued from the organization to be submitted in college.

For details of Research Project Guidelines refer following link

https://drive.google.com/file/d/1l9hsRma6hrq6DxJ6yi-bnN9iZJNkGm-6/view?usp=sharing

Evaluation and Examination Scheme

Evaluation Scheme 60:40

Internals Based on Unit 1 / Unit 2 / Unit 3 / Unit 4

Assignments/ Tutorials/Class Test	Seminar or any other activities	Active Participation & Leadership qualities	Total
30	05	05	40

Theory Examinations: For Paper 1, Paper 2, Paper 3 and Elective

Suggested Format for Mandatory Question paper

Duration: 2 hr. 30 min **Total Marks: 60**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.1.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.2.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.2.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.3.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.3.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.4.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.4.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
			**********	

Suggested Format for Elective Question paper:

23BPEV_T0_/0_/20_

Duration: 1 hr. 30 min **Total Marks: 30**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.1.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.2.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.2.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		

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Semester End Practical Examination:

Practical examination of each paper for 50 marks will be held for 4 hours.

Marks Distribution and Passing Criterion for Each Semester

Semester - I

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
23BPDS1T01	40	16	60	24	100	23BPDS1P01	**50**	**20**
23BPDS1T02	40	16	60	24	100			
23BPDS1T03	40	16	60	24	100			
E-I 23BPDS1T04	40	16	60	24	100	23BPDS1P02	**50**	**20**
E-II 23BPDS1T05	40	16	60	24	100	23BPDS1P03	**50**	**20**
23BPRM1T07	40	16	60	24	100			

Semester - II

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
23BPDS2T01	40	16	60	24	100	23BPDS2P01	**50**	**20**
23BPDS2T02	40	16	60	24	100			
23BPDS2T03	40	16	60	24	100			
E-I 23BPDS2T04	20	08	30	12	50	23BPDS2P02	**50**	**20**
E-II 23BPDS2T05	20	08	30	12	50	23BPDS2P03	**50**	**20**
						23BPDS2P04	**50**	**20**

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
Curriculum Structure for the Post Graduate Degree Programme M.Sc. Data Science

	SEMESTER–I	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Mandatory Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BPDS1T01	Fundamentals of Data Science	✓	✓	✓	-	-	-	-
23BPDS1T02	Databases and Data Warehousing	✓	✓	✓	-	-	-	-
23BPDS1T03	Introduction to Data Analysis and Statistical Computing	✓	✓	✓	-	-	-	-
23BPDS1P01	Practicals Based on 23BPDS1T01 and 23BPDS1T02	✓	✓	✓	-	-	-	-
	Elective Course Title							
23BPDS1T04	Python Programming	✓	✓	✓	-	-	-	-
23BPDS1P02	Practicals Based on 23BPDS1T04	✓	✓	✓	-	-	-	-
	OR							
23BPDS1T05	JAVA Programming	✓	✓	✓	-	-	-	-
23BPDS1P03	Practicals Based on 23BPDS1T05	✓	✓	✓	-	-	-	-
	Research Project (RP)							
23BPRM1T04	Research Methodology in I.T.	✓	✓	✓	-	--	-	-

	SEMESTER–II	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Mandatory Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BPDS2T01	Big Data Analytics	✓	✓	✓	-	-	-	-
23BPDS2T02	Next Generation Databases	✓	✓	✓	-	-	-	-
23BPDS2T03	High Performance Computing	✓	✓	✓	-	-	-	-
23BPSD2P01	Practicals Based on 23BPDS2T02 and 23BPDS2T03	✓	✓	✓	-	-	-	-
	Elective Course Title							
23BPDS2T04	Data Mining	✓	✓	✓	-	-	-	-
23BPDS2P02	Practicals Based on 23BPDS2T04	✓	✓	✓	-	-	-	-
	OR							
23BPDS2T05	Cloud Management	✓	✓	✓	-	-	-	-
23BPDS2P03	Practicals Based on 23BPDS2T05	✓	✓	✓	-	-	-	-
	Research Project (RP)							
23BPDS2P04	ON-JOB TRAINING (OJT) / FIELD PROJECT (FP) in Data Science	✓	✓	✓	✓	--	--	--

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