SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

Estd. 1962
"A++" Accredited by
NAAC (2021)
With CGPA 3.52

Ref.No.SU/BOS/Science/150 **Date: 26/05/2026.**

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur

The Head/Co-ordinator/Director
All Concerned Department (Science)
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of degree programme under the Faculty of Science and Technology as per NEP-2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of degree programme under the Faculty of Science and Technology as per NEP-2020.

1.	B.Sc. Part II Medicinal Chemistry (Entire) (2.0)	6.	BCA Part III
2.	B.A./B.A.B.Ed Part III Geography (2.0)	7.	B.Sc. Part II Data Science
3.	B.Sc. Part II Artificial Intelligence	8.	B.Sc.-M.Sc. Part III AI & ML
4.	B.Sc.-M.Sc. Part IV Nano Science and Technology (1.0)	9.	MCA Part II (YCSRD)
5.	B.Sc.-M.Sc. Part III Nano Science and Technology (2.0)	10.	MCA Part II

This syllabus, nature of question and equivalence shall be implemented from the academic year 2026-2027 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2026 & March/April 2027. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Encl: as above

for information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.A.,OE-II & B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

SHIVAJI UNIVERSITY, KOLHAPUR

NAAC A++ Grade with CGPA 3.52

As per

National Education Policy (NEP-2020)

Syllabus for

B.Sc. Data Science

(Under Faculty of Science and Technology)

PART-II SEMESTER III & IV

(Syllabus to be implemented from Academic Year 2026-27)

Multiple Entry and Multiple Exit Option (NEP-2020)
B.Sc. Data Science Programme Structure
B.Sc. Part – II (Level-5.0)
With Mathematics as Minor

SEMESTER-III (Duration- Six Month)

Sr. No.	Course Code	Teaching Scheme			Examination Scheme			
		Theory and Practical			University Assessment (UA)		Internal Assessment (IA)	
		Lectures (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Maximum Marks	Minimum Marks
1	**Subject I Major V** Advanced Python Programming	2	-	2	30	12	20	08
2	**Subject I Major VI** Advanced Database	2	-	2	30	12	20	08
3	**Subject I Major Practical III** : Practical Based on Subject I Major V & Major IV	-	4	2	30	12	20	08
4	**Minor V:** Linear Algebra	2	-	2	30	12	20	08
5	**Minor VI :** Numerical Methods	2	-	2	30	12	20	08
6	**Minor Practical III:** Practical based on Minor V and Minor VI	-	4	2	30	12	20	08
7	**OE – III (T/P) :** To be opted from other faculty (ie.B.Com or BA) Basket	2	-	2	30	12	20	08
8	**VSC – I (T)(Major specific) :** Web Design using JavaScript	2	-	2	30	12	20	08
9	**SEC-I (T/P):** Java Programming - I	-	4	2	30	12	20	08
10	**AEC-I(English) :** Verbal Communication	-	4	2	30	12	20	08
11	**CC-I :** Basics of Yoga	2	-	2	30	12	20	08
	Total (A)			**22**	**330**	**-**	**220**	**-**

SEMESTER-IV								
Sr. No.	Course Code	Teaching Scheme			Examination Scheme			
		Theory and Practical			University Assessment (UA)		Internal Assessment (IA)	
		Lectures (Per week)	Practical (Per week)	Credit	Maximum Marks	Minimum Marks	Maximum Marks	Minimum Marks
1	**Subject I Major VII :** Data Visualization using Python	2	-	2	30	12	20	08
2	**Subject I Major VIII :** NoSQL Database	2	-	2	30	12	20	08
3	**Subject I Practical IV** Practical Based on Subject I Major VII	-	4	2	30	12	20	08
4	**Subject II Minor VII** Computational Geometry	2	-	2	30	12	20	08
5	**Subject II Minor VIII** Operation Research	2	-	2	30	12	20	08
6	**Subject II Practical VI:** Practical Based on Subject Minor	-	4	2	30	12	20	08
7	**OE – IV (T/P) :** To be opted from other faculty (ie.B.Com or BA) Basket	2	-	2	30	12	20	08
8	**SEC-II(T/P) :** Java Programming - II	2	-	2	30	12	20	08
9	**AEC-II(English) :** Business Communication	-	4	2	30	12	20	08
10	**VEC – II (T) :** Environment Studies	-	4	2	30	12	20	08
11	**CEP-I (P) :** Field Work	2	-	2	30	12	20	08
	Total (B)			**22**	**330**		**220**	
	Total (A+B)			**44**	**660**		**440**	

OE: Open Elective	**SEC: Skill Enhancement Course**
VSC: Vocational Skill Course	**AEC: Ability Enhancement Course**
CC: Co-Curricular Course	**CEP: Community Engagement Program**

Multiple Entry and Multiple Exit Option (NEP-2020)
B.Sc. Data Science Programme Structure
B.Sc. Part – II (Level-5.0)
With Statistics as Minor

SEMESTER-III (Duration- Six Month)								
Sr. No.	Course Code	**Teaching Scheme**			**Examination Scheme**			
		Theory and Practical			University Assessment (UA)		Internal Assessment (IA)	
		Lectures (Per week)	Practical (Per week)	Credit	Maximum Marks	Minimum Marks	Maximum Marks	Minimum Marks
1	**Subject I Major V** Advanced Python Programming	2	-	2	30	12	20	08
2	**Subject I Major VI** Advanced Database	2	-	2	30	12	20	08
3	**Subject I Major Practical III** : Practical Based on Subject I Major V & Major IV	-	4	2	30	12	20	08
4	**Minor V:** Descriptive Statistics	2	-	2	30	12	20	08
5	**Minor VI :** R Programming	2	-	2	30	12	20	08
6	**Minor Practical III:** Practical based on Minor V and Minor VI	-	4	2	30	12	20	08
7	**OE – III (T/P) :** To be opted from other faculty (ie.B.Com or BA) Basket	2	-	2	30	12	20	08
8	**VSC – I (T)(Major specific) :** Web Design using JavaScript	2	-	2	30	12	20	08
9	**SEC-I (T/P):** Java Programming - I	-	4	2	30	12	20	08
10	**AEC-I (English) :** Verbal Communication	-	4	2	30	12	20	08
11	**CC-I :** Basics of Yoga	2	-	2	30	12	20	08
	Total (A)			**22**	**330**		**220**	

SEMESTER-IV (Duration- Six Month)

Sr. No.	Course Code	Teaching Scheme			Examination Scheme			
		Theory and Practical			University Assessment (UA)		Internal Assessment (IA)	
		Lecture (Per week)	Practical (Per week)	Credit	Maximum Marks	Minimum Marks	Maximum Marks	Minimum Marks
1	**Subject I Major VII :** Data Visualization using Python	2	-	2	30	12	20	08
2	**Subject I Major VIII :** NoSQL Database	2	-	2	30	12	20	08
3	**Subject I Practical IV** Practical Based on Subject I Major VII	-	4	2	30	12	20	08
4	**Subject II Minor VII** Statistical Inference	2	-	2	30	12	20	08
5	**Subject II Minor VIII** Stochastic Processes	2	-	2	30	12	20	08
6	**Subject II Practical VI:** Practical Based on Subject Minor	-	4	2	30	12	20	08
7	**OE – IV (T/P) :** To be opted from other faculty (ie.B.Com or BA) Basket	2	-	2	30	12	20	08
8	**SEC-II(T/P) :** Java Programming - II	2	-	2	30	12	20	08
9	**AEC-II(English) :** Business Communication	-	4	2	30	12	20	08
10	**VEC – II (T) :** Environment Studies	-	4	2	30	12	20	08
11	**CEP-I (P) :** Field Work	2	-	2	30	12	20	08
	Total (B)			**22**	**330**		**220**	
	Total (A+B)			**44**	**660**		**440**	

OE: Open Elective	**SEC: Skill Enhancement Course**
VSC: Vocational Skill Course	**AEC: Ability Enhancement Course**
CC: Co-Curricular Course	**CEP: Community Engagement Program**

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: Subject I Major V: Advanced Python Programming

Course Outcomes:

After completion of this course students will be able to:

1. Understand and apply advanced Python concepts including namespaces, modules, decorators, generators, iterators, and debugging techniques.
2. Design and implement object-oriented Python programs using inheritance, polymorphism, abstraction, encapsulation, special methods, and exception handling mechanisms.
3. Develop multithreaded applications using Python threading modules with synchronization techniques such as Lock and Semaphore.
4. Build database-driven applications using Python DB-API by executing SQL queries and implementing basic CRUD operations.

Unit I **(15 Hours)**

Advanced Python Fundamentals: Namespaces and modules, virtual environments, advanced importing, decorators, generators and iterators, debugging techniques.

Object Oriented Programming in Python : Classes and objects, constructors and destructors, instance and class variables, inheritance, method overriding, polymorphism, abstraction, encapsulation, multiple inheritance, special (dunder) methods.

Exception Handling: Exceptions in object-oriented context, handling exceptions using try–except–finally, raising exceptions using raise, creating custom exception classes.

Unit II **(15 Hours)**

Multithreading and Concurrency in Python : Concept of Process vs Thread,Python threading module: creating and running threads,thread lifecycle, Extending the Thread class,Daemon threads, Thread synchronization using Lock and Semaphore.

Database Connectivity : Python DB-API concept, connecting Python with relational databases, executing SQL queries from Python, fetching results into objects/DataFrames, basic CRUD applications.

Reference Books:

1. Mark Lutz, Learning Python, O'Reilly Media, 5th Edition, 2013
2. Luciano Ramalho, Fluent Python, O'Reilly Media, 2nd Edition, 2022
3. Dusty Phillips, Python 3 Object-Oriented Programming, Packt Publishing, 3rd Edition, 2018
4. Rick van Hattem, Mastering Python, Packt Publishing, 2nd Edition, 2016

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: Subject I Major VI: Advanced Database

Course Outcomes:

After completion of this course students will be able to:

1. Understand and apply PL/pgSQL block structure, variables, data types, and control statements.
2. Design and implement stored functions, procedures, and Common Table Expressions (CTEs) for database applications.
3. Create and manage database objects including views, cursors, triggers, and exception handling mechanisms.
4. Analyze and optimize database performance using indexing techniques and query optimization tools.

Unit I **(15 Hours)**

Introduction to PL/pgSQL: Overview, benefits and architecture, structure of PL/pgSQL blocks, anonymous blocks using DO statement.

Variables and Data Types: Scalar data types, RECORD type, %ROWTYPE and %TYPE attributes, variable declaration and assignment, output using RAISE NOTICE.

SQL Integration and Control Structures: Executing SELECT, INSERT, UPDATE and DELETE inside PL/pgSQL, transaction control, conditional statements, loops .

Functions and Procedures: Creating stored functions and procedures, IN and OUT parameters, returning tables from functions, calling functions from SQL.

Unit II **(15 Hours)**

Advanced Database Objects: Views and Materialized Views, constraints and rules.

Cursors and Exception Handling: Implicit and explicit cursors, cursor FOR loops, exception handling using EXCEPTION blocks.

Triggers: Introduction to triggers and their role in automation, creating triggers to respond to table events, BEFORE INSERT and AFTER INSERT triggers, dropping triggers, disabling triggers.

Indexing and Query Optimization: Concept of index and its role in query performance, CREATE INDEX and DROP INDEX, unique index, expression index, partial indexes, index-only scans.

[**Note**: PostgreSQL will be used as the primary database platform for delivering both theoretical concepts and practical exercises in this course.]

Reference Books:

1. Baji Shaik, Dinesh Kumar Chemuduru, Procedural Programming with PostgreSQL PL/pgSQL: Design Complex Database-centric Applications with PL/pgSQL, Apress, 1st Edition (2023)
2. Regina O. Obe, Leo S. Hsu, PostgreSQL: Up and Running, O'Reilly Media, 3rd Edition (2017)
3. Swati Saxena, Essential PostgreSQL: Your Guide to Database Design, Query Optimization, and Administration, BPB Publications, 1st Edition (2025)
4. Sayak Ghosh, Fundamentals of SQL, IP Innovative Publication, 1st Edition (2022)

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: Subject I Major Practical III :
Practical Based on Subject I Major V & Subject I Major IV

Course Outcomes:
After completion of this course students will be able to:

1. Develop advanced Python programs using modules, object-oriented programming concepts, special methods, and exception handling mechanisms.
2. Design and implement database-driven Python applications by integrating relational databases and performing CRUD operations.
3. Apply PL/pgSQL programming constructs including variables, control structures, and SQL integration to manipulate database records.
4. Create and manage stored functions and procedures using PL/pgSQL to build structured and reusable database applications.

Practical Based on Subject: Subject I Major V Advanced Python Programming

1. Write a program to demonstrate namespaces and modules by creating and importing a user-defined module.
2. Write a program using generators and iterators to generate Fibonacci numbers.
3. Write a program to create a class and object, including constructor and destructor.
4. Write a program demonstrating instance variables and class variables.
5. Write a program to implement single inheritance and method overriding.
6. Write a program to implement encapsulation and multiple inheritance.
7. Write a program demonstrating special (dunder) methods such as __str__, __add__, and __len__.
8. Write a program to handle exceptions using try–except–finally and raise.
9. Write a program to create and use a custom exception class.
10. Write a program to connect Python with a relational database and perform CRUD operations (Create, Read, Update, Delete).

Practical Based on Subject : Subject I Major VI Database - II

1. Write a PL/pgSQL program to demonstrate variable declaration, assignment, and scalar data types.
2. Create a table Student(Student_ID, Name, Age, Dept_ID) and write a PL/pgSQL block to insert records using variables.
3. Write a PL/pgSQL program using %TYPE to fetch and display a student's name based on Student_ID.
4. Write a PL/pgSQL program using %ROWTYPE to retrieve and display complete student records.
5. Write a PL/pgSQL block using RECORD type to fetch values from a table.
6. Write a PL/pgSQL program to perform following operations inside PL/pgSQL.:
    a. a. INSERT
    b. b. UPDATE
    c. c. DELETE
    d. d. SELECT
7. Write PL/pgSQL programs using to classify students based on marks.:
    a. IF–ELSE statement
    b. CASE statement
8. Write PL/pgSQL programs using loops to display numbers or table records.:
9. Create a stored function that accepts Student_ID as input and returns student age.
10. Create a stored function returning a table to display students of a particular department.
11. Create a stored procedure with IN and OUT parameters to insert student data.

[**Note**: PostgreSQL will be used as the primary database platform for delivering both theoretical concepts and practical exercises in this course.]

Advanced Python

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Course Title: Minor: Linear Algebra (Minor)

Course Outcomes:

After complete on of this course, student should be able to

1. Understandtheconceptoflineartransformationanditsapplicationtoreallifeapplications.
2. Evaluate mathematical expressions to compute quantities that deal with linear systems and Eigen value problems.
3. Analyze mathematical statements and expressions.

UNIT - I Linear Equations and Matrices **(15 Hours)**

1.1 Matrices
1.2 Matrix Transformation
1.3 Linear Systems
1.4 Results on system of linear equations and invertible matrices
1.5 Solutions of System of LinearEquations
    1.5.1 GaussElimination Method
    1.5.2 Gauss-JordonMethod
1.6 Eigenvalues, Eigenvectors and diagonalization
    1.6.1 Eigenvalues and Eigen Vectors
    1.6.2 Diagonalization
    1.6.3 Cayley-Hamiltoniantheorem(StatementOnly)and Examples

UNIT - 2 Vector Space **(15 Hours)**

2.1 VectorSpace
2.2 Sub Space
2.3 LinearDependent and Independent
2.4 Linear Span
2.5 Basis and Dimension
2.6 DefinitionandExamples ofInnerProductSpace
    2.6.1 DefinitionandExamples
    2.6.2 PropertiesofInnerProductSpace
    2.6.3 OrthonormalBasisinR
    2.6.4 Gram-SchmidtProcess

***Note**: All theoremsinsections1.4, 1.6,2. 5 ,2. 6 are without proof.

Recommended Book: Elementary Linear Algebra with Applications , Howard Anton, Chris Rorres, JohnWileyandsons., 7th Edition (1994).

REFERENCE BOOKS:

1. A textbook of Matrices ,Shanti Narayan, P.K.Mittal,S. Chand.
2. To pics in Algebra,I. N.Herstein.
3. Linear Algebra,SchaumSeries.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Course Title : Minor VI : Numerical Methods (Minor)

Course Outcomes:

After completion of this course, student should be able to

1. Understand how to find the roots of transcendental equations.
2. Understand learn numerical solution of differential equations
3. Understand how to find the roots of transcendental equations.
4. Understand how to interpolate the given set of values.

Unit I: Solution of Non-linear Equations & Interpolation (15 Hours)

1.1 Introduction to Non-linear Equations
1.2 Bisection Method: Algorithm, graphical representation and examples
1.3 Regula–Falsi Method: Algorithm, graphical representation and examples
1.4 Newton-Raphson Method: Algorithm, graphical representation and examples
1.5 Interpolation: Introduction, equally spaced data, unequally spaced data
1.6 Finite Differences and Operators: Forward Difference (Δ), Backward Difference (∇), Shift Operator (E)
1.7 Elementary Results of Δ, ∇and E
1.8 Fundamental Theorem of Difference Calculus with proof
1.9 Newton-Gregory Forward Interpolation Formula with proof and examples
1.10 Newton-Gregory Backward Interpolation Formula with proof and examples
1.11 Lagrange's Interpolation Formula with proof and examples

Unit II: Numerical Integration (15 Hours)

2.1 Introduction to Numerical Integration
2.2 General Quadrature Formula with proof
2.3 Trapezoidal Rule with proof and examples
2.4 Simpson's 1/3 Rule with proof and examples
2.5 Simpson's 3/8 Rule with proof and examples
2.6 Weddle's Rule with proof and examples

Recommended Book:

1. IntroductoryMethodsofNumericalAnalysis,S.S.Sastry,3rd edition, Prentice Hall of India, 1999.
2. Finite differences and Numerical Analysis, sH.C. Saxena,S. Chand and Company.

REFERENCE BOOKS:

1. NumericalAnalysis,Balguruswamy.
2. CalculusofFiniteDifferencesandNumericalAnalysis,P.P.Gupta,G.S.MalikandS. Gupta,Krishna Prakashan Media (P) Ltd.
3. Computer oriented Numerical methods, A.B.AutiTech-maxpublications.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Minor Practical- III
Mathematics Practical based on Minor V and VI (Minor)

List of Practical:

Practical Number	Title of the practical
1	Gauss Elimination Method and Gauss-Jordon Method
2	Eigen values and Eigenvectors, Diagonalization
3	Verification of Cayley-Hamiltontheorem
4	Inverse of a matrix using Cayley-HamiltonTheorem
5	Examples on Basis of Vector Space
6	GramSchmidtprocess
7	Bisection method
8	Newton Forward and Backward interpolation, Lagrange'sinterpolation
9	Trapezoidal,Simpson's1⁄3andSimpson's3⁄8rule
10	Weddle's rule
11	Regula-FalsiMethodandNewtonRaphsonmethod
12	Computer Program for 1) Trapezoidal rule 2) Simpson1⁄3ruleand Simpson3⁄8 rule 3) Weddle's rule 4) Bisectionmethod,Regula-FalsiMethodandNewtonRaphson method

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Course Title : Minor V : Descriptive Statistics (Minor)

Course Outcomes:

After completion of this course students will be able to:

1. Study correlation between two variables by using diagrams and graphs.
2. Study methods to quantify correlation between two or three variables
3. Perform the analysis for tri-variate data
4. Estimate the value of dependent variable for given values of independent variable

Unit - I Correlation

Concept of bivariate data, scatter diagram. Concept of correlation, positive correlation, negative correlation, cause and effect relation, Karl Pearson's coefficient of correlation, Properties of correlation coefficient, interpretation of correlation coefficient, Spearman's Rank Correlation coefficient (formula with and without ties), Multiple and Partial Correlation: Concept, definition, formulae and properties, Examples.

Unit - II Regression

Concept of regression. Derivation of lines of regression by method of least squares, Regression Coefficients, and their significance. Properties of regression coefficients, Point of intersection and acute angle between regression lines, Multiple regression: Concept of multiple regressions. Yule's Notations, Fitting of multiple regression planes. Partial regression coefficients, interpretations, Logistic regression, Numerical problems.

Reference Books:

1. S. C. Gupta and V. K. Kapoor, Fundamental of Mathematical Statistics (12th Edition), Delhi, Sultan Chand and Sons, 2020
2. T.C. Gupta. Fundamental of Statistics (7th Edition), Mumbai, Himalaya Publishing House, 2018.
3. Gentle, E. James, Numerical Linear Algebra for Applications in Statistics. Springer, 2018.
4. Efron, Bradley, Hastie Trevor, Computer Age Statistical inference Algorithms, Evidence, and Data Science. Cambridge University Press, 2016.
5. S. P. Gupta, Sultan Chand, Statistical Methods, Delhi, 2014

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Course Title : Minor VI : R Programming(Minor)

Course Outcomes (COs)

After completion of this course students will be able to:

1. Learn Fundamentals of R.
2. Covers how to use different functions in R, how to read data into R, accessing R packages, writing R functions, debugging, and organizing data using R functions.
3. Cover the Basics of statistical data analysis with examples.
4. The whole syllabus will give an idea to collect, compile and visualize data using statistical functions.

Unit I : Introduction to R

What is R? – Why R? – Advantages of R over Other Programming Languages - R Studio: R command Prompt, R script file, comments – Handling Packages in R: Installing a R Package, Few commands to get started: installed.packages(), packageDescription(), help(), find.package(), library() - Input and Output – Entering Data from keyboard – Printing fewer digits or more digits – Special Values functions : NA, Inf and –inf.

R Data Types: Vectors, Lists, Matrices, Arrays, Factors, Data Frame – R - Variables: Variable assignment, Data types of Variable, Finding Variable ls(), Deleting Variables - R Operators: Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators, Miscellaneous Operators - R Decision Making: if statement, if – else statement, if – else if statement, switch statement – R Loops: repeat loop, while loop, for loop - Loop control statement: break statement, next statement.

Unit II : R utilities

R-Function : function definition, Built in functions: mean(), paste(), sum(), min(), max(), seq(), user-defined function, calling a function, calling a function without an argument, calling a function with argument values - R-Strings – Manipulating Text in Data: substr(), strsplit(), paste(), grep(), toupper(), tolower() - R Vectors – Sequence vector, rep function, vector access, vector names, vector math, vector recycling, vector element sorting -

R List -Creating a List, List Tags and Values, Add/Delete Element to or from a List, Size of List, Merging Lists, Converting List to Vector - R Matrices – Accessing Elements of a Matrix, Matrix Computations: Addition, subtraction, Multiplication and Division- R Arrays: Naming Columns and Rows, Accessing Array Elements, Manipulating Array Elements, Calculation Across Array Elements - R Factors –creating factors, generating factor levels gl().

Reference Books:

1. Sandip Rakshit, R Programming for Beginners, McGraw Hill Education (India), 2017Seema Acharya, Data. Analytics using R, McGrawHill Education (India), 2018.
2. Andrie de Vries, Joris Meys, R for Dummies, A Wiley Brand, 2nd Edition, John Wiley and Sons, Inc, 2015.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: Statistics Practical based on Minor V and VI (Minor)

Course Outcomes:

After completion of this course students will be able to;

1. Show the installation of R Programming Environment.
2. Utilize and R Data types for developing programs.
3. Make use of different R Data Structures.
4. Develop programming logic using R Packages.
5. Analyze the datasets using R programming capabilities
6. Apply R programming for reading, cleaning, visualizing and analyzing data

Lab Work

1. Visualizing the relation between two variables using scatter plot
2. Karl Pearson's Correlation Coefficient
3. Spearmann's Rank Correlation Coefficient
4. Simple Linear Regression
5. Multiple Linear Regression
6. Write a program to demonstrate the use of conditional statements (if, if-else, ifelse) in R.
7. Implement R-Loops with different examples.
8. Learn the basics of functions in R and implement them with examples.
9. Implement data frames in R. Write a program to join columns and rows in
10. Data frame using cbind() and rbind() in R
11. Implement different String Manipulation functions in R.
12. Implement different data structures in R (Vectors, Lists, Data Frames).
13. Create pie charts and bar charts using R
14. Create a data set and do statistical analysis on the data using R
15. Use the apply(), lapply(), and sapply() functions on matrices and lists to perform operations like sum and mean.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: VSC – I (T) : Web Design using JavaScript

Course Outcomes:

After completion of this course students will be able to:

1. Understand different HTML tags.
2. Learn how to design and develop a Web page using HTML and CSS
3. Design and develop a web site using text, images, links, lists and tables.
4. Develop simple object-oriented JavaScript programs using arrays, objects, and properties.

UNIT-I **(15 Hours)**

Introduction to web design principles, overview of web development technologies and tools, understanding the role of HTML, CSS, and JavaScript, HTML basics, HTML elements, Attributes, heading, paragraphs, Styles, Formatting, Quotations, colors, links, images, table, list tags, Iframe, File paths, HTML layouts, Introduction to CSS syntax and selectors, applying styles to HTML elements, managing layouts using CSS

UNIT-II **(15 Hours)**

Overview of JavaScript and its role in web development, setting up the development environment, Writing and executing JavaScript code, Declaring and assigning variables, working with numbers, strings, booleans, and arrays, Type coercion and type conversion, Conditional statements, Switch statements, Loops, Break and continue statements, Element Access in Java scripts, Event and event handling, dialog boxes, Defining and invoking functions, working with arrays, Introduction to objects and properties, Object-oriented programming concepts

Reference Books:

1. lisabeth Robson, Eric Freeman - Head First HTML and CSS - O'Reilly Media, 2nd Edition, 2012
2. Julie C. Meloni, Jennifer Kyrnin - HTML, CSS, and JavaScript All in One, Pearson (Sams Publishing), 1st Edition, 2015
3. Andy Harris - HTML5 and CSS3 All-in-One For Dummies - John Wiley & Sons, 3rd Edition, 2014

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: SEC-I (T): Java Programming - I

Course Outcomes:

After completion of this course students will be able to:

1. Understand Java fundamentals including JVM architecture, data types, control structures, arrays, and predefined classes.
2. Design object-oriented programs using classes, constructors, inheritance, polymorphism, abstraction, and interfaces.
3. Apply encapsulation, packages, access modifiers, and exception handling to develop robust Java applications.
4. Develop structured Java programs using user-defined exceptions, interfaces, and core OOP principles.

Unit I **(15 Hours)**

Introduction to Java: Introduction to Java, History and Features of Java, C++ vs Java, JDK vs JRE vs JVM, Java Virtual Machine (JVM – basic architecture), Compilation and Execution Process, First Java Program, Accepting Input (Command Line Arguments, Scanner).
Programming Basics: Variables in Java, Java Data Types, Type Casting, Java Operators, Control Flow Statements, Loops, break and continue statements, Java Arrays (1D and 2D).
Predefined Classes: Object Class (equals(), toString(), hashCode(), getClass()), String Class, StringBuilder Class, Wrapper Classes.

Unit II **(15 Hours)**

Object Oriented Programming in Java: Classes and Objects, Constructors, Methods and Types of Methods, Static keyword (variables, methods, blocks).
Inheritance and Polymorphism: Inheritance using extends, Types of Inheritance, Superclass and Subclass, super keyword, Method Overriding, Use of final keyword related to method and class.
Abstraction and Interfaces: Abstract class and abstract methods, Defining and Implementing Interfaces, Runtime polymorphism using Interface.
Encapsulation and Packages: Encapsulation (getters and setters), Packages, Access Modifiers (public, private, protected, default).
Exception Handling: Exception Handling Concepts, Checked and Unchecked Exceptions, try–catch–finally, throw and throws, User-defined Exceptions.

Reference Books:

1. Herbert Schildt - Java: The Complete Reference, McGraw-Hill Education, 11th Edition, 2019
2. Paul Deitel, Harvey Deitel - Java How to Program, Pearson Education, 10th Edition, 2015
3. Cay S. Horstmann - Core Java Volume I – Fundamentals, Prentice Hall, 11th Edition, 2018
4. E. Balagurusamy - Programming with Java, McGraw-Hill Education (India), 6th Edition, 2019

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: AEC - I: Verbal Communication

Course Outcomes:

After completion of this course students will be able to:

1. Demonstrate Proficiency in Grammar and Sentence Structures.
2. Demonstrate effective oral communication for various purposes including introductions, apologies, and expressing agreement or disagreement.
3. Participate in structured conversational activities like monologues, dialogues, role plays, and situational conversations.
4. Develop group discussion and interview skills by practicing initiation, continuation, and conclusion techniques.

UNIT I **(15 Hours)**

Basic Language Skills: Grammar: Sentence Structures/Patterns, Subject - Verb agreement, Tenses. Vocabulary : Synonyms and Antonyms, Homonyms, One-word substitutes, Idioms, Suffixes and prefixes Collocations. Speaking for Different Purpose: Meeting and Greeting People, Introducing your Self, Introducing People to One another, Apologies and Responses, Agreeing and Disagreeing, General Speaking Strategies. Conversational Activities – Monologues, Introducing yourself, Introducing others, One-minute impromptu speeches, Scaffolded storytelling, Conversational Activities – Dialogues. Role plays on everyday interactions, Information Gap Activities, Picture descriptions and feedback, Situational conversations.

UNIT II **(15 Hours)**

Group Discussion, Interview and Interviewing Skills, Initiating a Group Discussion, Continuing a Group Discussion, Concluding Group Discussion, Preparing for an Interview, Facing an Interview, Interviewing Techniques. Conversational Activities - Pronunciation, Stress & Rhythm, Intonation, Neutralization of accent, Word stress, Rhythm & Pauses, Tonal variations/inflections Presentation Skills: Kinds of Presentation, Structuring Content, Visual Aids, the Language of Presentations, Making a Presentation.

Reference Books:

1. Barret Grant. Perfect English Grammar: The Indispensable Guide to Excellent Writing and Speaking. Fall River Press, 2016
2. Monippally, Matthukutty, M. Business Communication Strategies. New Delhi: Tata McGraw-Hill Publishing Company Ltd., 2001
3. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraHillPublishingCompanyLimited,2001.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM III(Level- 5.0)
Title of course: CC-I: Basics of Yoga

Course Outcomes:

After completion of this course students will be able to:

1. To understand the importance of Yoga and understand various Asans.
2. Classify and differentiate various types of yoga including Jnana, Bhakti, Karma, Hatha, and Raja Yoga.
3. Analyze the role of yoga in character building, mental discipline, and stress management through techniques like Nishkama Karma and meditation.
4. Explore the therapeutic values of yoga, yogic literature, and the lives and contributions of yogis like Swami Vivekananda and Sri Aurobindo.

UNIT I **(15 Hours)**

Yoga Definition, Objectives of yoga Education Difference between Yoga Asana, and physical exercises, Importance of Yoga in daily life, Methods and benefits of Asanas, Pranayama and Concentration, Knowledge of five yama with more emphasis on 'Asteya', Knowledge of five Niyama with emphasis on 'Santosh', Knowledge of Aahar-Vihar, Methods and benefits of Sukshma, Vyayama, Asanas and prayers. Types of Yoga: Jnana Yoga, Bhakti Yoga, Karma Yoga, Hatha Yoga,Raja Yoga.

UNIT II **(15 Hours)**

Role of yoga in character building, Therapeutic values of yoga, Introduction of yoga literature, Life history of Arvindo, Vivekanand and other yogis, Knowledge of Bandha, Mudra and Chakras, Methods and benefits of Asans, Pranayama and Concentration Effects of Asanas and Pranayama on physiology of human body, Concept of Nishkama Karma Yoga, Role of Yoga practices in developing concentration, will power and discipline, Techniques of stress management, Methods and benefits of Asanas, Pranayama and concentration

Reference Books:

1. Light on Yoga by B.K.S. Iyengar
2. The Yamas & Niyamas: Exploring Yoga's Ethical Practice by Deborah Adele

B.Sc. B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: Subject I Major VII : Data Visualization using Python

Course Outcomes (COs)

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

1 Explain the role of data visualization and exploratory data analysis in data-driven decision making.
2 Apply NumPy and Pandas for data preprocessing, cleaning, and transformation.
3 Create effective visualizations using Matplotlib and Pandas for different data types.
4 Perform data aggregation using GroupBy and Pivot Tables and visualize summarized data.
5 Design basic interactive visualizations and dashboards using Plotly (introductory).

UNIT – I **(15 Hours)**

Introduction to Data Visualization, importance of visualization in data analysis, types of data and charts, basic visualization principles, Python environment setup (Anaconda/Jupyter), overview of NumPy, Pandas and visualization libraries, NumPy arrays (creation, data types, indexing, slicing, reshaping, arithmetic operations), data preprocessing using NumPy, Pandas data structures (Series and DataFrame), loading datasets, indexing and filtering, handling missing data, basic statistical operations using Pandas, introduction to exploratory data analysis (EDA), preparing data for visualization.

UNIT – II **(15 Hours)**

Plotting using Matplotlib (figures, subplots, colors, labels, legends), line plots, bar charts, scatter plots and histograms, visualization using Pandas, heatmaps (basic), groupby operations and data aggregation, split–apply–combine strategy, pivot tables and cross tabulation, visualization of aggregated data, introduction to interactive visualization using Plotly (overview), dashboard-style visualizations (conceptual), mini case studies using real datasets.

Reference Books

1. Wes McKinney, Python for Data Analysis, O'Reilly Media, 2017.
2. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016.
3. Claus O. Wilke, Fundamentals of Data Visualization, O'Reilly Media, 2019.
4. Michael Bowles, Machine Learning in Python: Essential Techniques, Wiley, 2015.
5. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012.

B.Sc. B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: Subject I Major VIII : NoSQL Database

Course Outcomes:

After completion of this course students will be able to:

1. Explain the need for NoSQL databases and differentiate between relational and NoSQL data models.
2. Describe aggregate-oriented data models and compare key–value, document, column-family, and graph databases.
3. Analyze distributed data management concepts including sharding, replication, and CAP theorem.
4. Apply MapReduce concepts and implement basic operations using key–value and document databases.
5. Design simple data models and identify appropriate NoSQL databases for real-world applications such as analytics, recommendation systems, and social networks.

UNIT I **(15 Hours)**

Introduction to NoSQL and Data Models : Why NoSQL, limitations of relational databases, emergence of NoSQL, aggregate data models, key-value, document, column-family and graph databases (overview), relationships in NoSQL, schemaless databases, basic modeling concepts.

Distributed Data Management : Single server vs distributed systems, sharding, replication, master-slave and peer-to-peer models, CAP theorem, consistency models.

UNIT II **(15 Hours)**

MapReduce and Key-Value Stores : MapReduce programming model, basic MapReduce example, introduction to key-value databases, features, suitable use cases (session data, user profiles).

Document Databases : Document databases overview, features, querying documents, scaling, applications in content management, analytics and e-commerce.

Graph Databases and Applications : Graph database concepts, nodes and relationships, graph queries, applications in recommendation systems, routing, social networks.

Reference Books:

1. Martin Fowler and Pramod Sadalage, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison-Wesley, 2013.
2. Kristina Chodorow, MongoDB: The Definitive Guide, O'Reilly Media, 2013.
3. Rick Copeland, MongoDB Applied Design Patterns, O'Reilly Media, 2013.
4. Eric Redmond and Jim R. Wilson, Seven Databases in Seven Weeks, Pragmatic Bookshelf, 2012.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: Subject I Practical IV : Practical Based on Subject I Major VII

1. Install Anaconda/Jupyter and verify Python visualization environment.
2. Create NumPy arrays and perform indexing, slicing, reshaping, and arithmetic operations.
3. Perform basic statistical operations on NumPy arrays.
4. Load CSV/Excel data into Pandas DataFrame.
5. Handle missing values (drop, fill, interpolate).
6. Filter, sort, and transform datasets using Pandas.
7. Perform basic EDA (describe, correlations, summary statistics).
8. Prepare a cleaned dataset for visualization (mini case).
9. Create line, bar, scatter, and histogram plots using Matplotlib.
10. Customize plots (titles, labels, legends, colors, subplots).
11. Visualize data directly from Pandas DataFrames.
12. Create heatmaps for correlation analysis.
13. Perform GroupBy operations and visualize aggregated results.
14. Create Pivot Tables and cross-tabulations with visual output.
15. Build comparative visualizations (multiple plots on same figure).
16. Introduction to interactive plots using Plotly (line/scatter).
17. Visualize categorical vs numerical data (box/violin – basic).
18. Case study: EDA + visualization on a real dataset.
19. Mini dashboard using Plotly (conceptual/simple).

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Course Title : Miner VII : Computational Geometry

Course Outcomes(COs):

On completion of the course, the students will be able to:

1. Understand how to represent point, lines, transformations and matrices.
2. Understand how to various types of transformations.
3. Solve multiple transformation and projection on three dimensional.
4. Understand the concept curve, its properties and B-spline curve.

UNIT - 1 Two dimensional transformations (15 Hours)

1.1 Introduction
1.2 Representation of Point
1.3 Basic2DTransformation:Scaling,Shearing,Rotation, Reflection
1.4 Combined Transformation
1.5 Transformation of points, straight lines
1.6 Midpoint Transformation
1.7 Slope of transformed line
1.8 Transformation of parallel lines and intersecting lines
1.9 Homogeneous coordinates and Homogeneous matrix
1.10 Rotation about an arbitrary point.
1.11 Reflection through an arbitrary line.
1.12 Solid body transformation
1.13 Point at infinity.

UNIT - 2 Three dimensional transformations (15 Hours)

3.1 Introduction.
3.2 Three dimensional-Scaling, Shearing, Rotation, Reflection, Translation.
3.3 Multiple transformations.
3.4 Rotation about-an axis parallel to coordinate axes, an arbitrary axis in space.
3.5 Reflection through-planes parallel to coordinate planes
3.6 Reflection through arbitrary plane(only algorithm).
3.7 Plane Curves
    3.7.1 Introduction.
    3.7.2 Curve representation
    3.7.3 Parametric representation of a circle and generation of circle.
    3.7.4 Parametric representation of an ellipse and generation of ellipse.
    3.7.5 Parametric representation of a parabola and generation of parabolic Segment

Recommended Book:

1. Mathematicalelementsforcomputergraphics,F.DavidandJ.AlanAdams(McGrawHill International Edition)

Reference Books:

1. Computer graphics,Schaumseries.
2. ComputerGraphicshandbook,GeometryandMathematics,M.E.Mortenson,IndustrialPressInc.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Course Title : Miner VIII : Operational Research

Course Outcomes (COs):
On completion of the course, the students will be able to:

1. learn about characteristics, scope of operation Research.
2. Understand the Assignment problem.
3. UnderstandtheTransportationproblemInitialSolutionandOptimization.
4. To know the fundamentals of game theory.

Unit I: Introduction to Operation Research and Transportation Problem (15 Hours)

1.1 Basics of Operation Research
1.2 Different definitions of Operation Research
1.3 Characteristics, scope, limitations of Operation Research
1.4 Basics of Transportation Problem
1.5 Basic Definitions
1.6 Initial Solution
    1.6.1 North-West Corner Method and examples
    1.6.2 Matrix Minima Method and examples
    1.6.3 Vogel's Approximation Method and examples
1.7 MODI Method and examples
1.8 Maximization in Transportation Problem and examples
1.9 Unbalanced Transportation Problem and examples

Unit II: Assignment Problem and Theory of Games (15 Hours)

2.1 Introduction to Assignment Problem
2.2 Hungarian Method and examples
2.3 Maximization in Assignment Problems and examples
2.4 Unbalanced Assignment Problem and examples
2.5 Assignment Problems with restrictions and examples
2.6 Basic definitions of Game Theory
2.7 Saddle Point and examples
2.8 Algebraic Method for 2×2 size game and examples
2.9 Arithmetic Method for 2×2 size game and examples
2.10 Principle of Dominance, Dominance Method and examples
2.11 Sub-game Method for 2×n and m×2 size game and examples
2.12 Graphical Method for 2×n and m×2 size game and examples

RecommendedBook:

1. OperationsResearch,S. D. Sharma

REFERENCE BOOKS:

1. PrinciplesofOperationsResearch,H.M.Wagner,PrenticeHallofIndia.
2. OperationsResearch,GuptaandHira.
3. Operations Research,JK Sharma(secondedition)

B.Sc. B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Course Title: Mathematics Practical based on Minor VII and VIII

List of Practical:

Practical Number	Title of the practical
1	PlaneLinear transformation – I Scaling,Shearing,ReflectionCombinedtransformation matrix
2	PlaneLinear transformation – II Rotationaboutorigin,Rotationaboutarbitrarypoint,Reflectionthrougharbitraryline
3	Spacelineartransformation–I Scaling,ShearingandRotationaboutCoordinateaxis,ReflectionthroughCoordinate planes
4	Spacelineartransformation–II TranslationMultipletransformations,RotationaboutalineparalleltoCoordinateaxis, Rotation through planes which are parallel to Coordinate planes
5	PlaneCurves – I Generationofpointsoncircleandellipse(Examples only)
6	PlaneCurves_ II Generationofpointsonparabolicsegment(Examples only)
7	Initialsolutionoftransportationproblem – I North–WestCornermethod,Matrixminima method
8	Initialsolutionoftransportationproblem–II Vogel's approximation method
9	Maximizationoftransportationproblem,Unbalancedtransportationproblem
10	AssignmentProblem-Minimizationtypeand Maximization in assignment problem,
11	Graphicalmethodfor□×□&□×□sizegame
12	ComputerProgram: 1) Tocheckgiventransformationissolidbodytransformation ornot. 2) TodeterminevalueofgameusingArithmeticMethod 3) TodeterminevalueofgameusingAlgebraicMethod

B.Sc. Data Science

Multiple Entry and Multiple Exit Option (NEP-2020)

PART II SEM IV(Level- 5.0)

Course Title : Miner VII : Statistical Inference(Minor)

Course Outcomes (COs)

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

1. Explain fundamental concepts of statistical inference including random variables, expectation, and sampling distributions.
2. Apply concepts of estimation and construct confidence intervals for population parameters.
3. Perform hypothesis testing using appropriate statistical tests for real-world data.
4. Interpret statistical results in the context of data analysis and artificial intelligence applications.

UNIT – I **(15 Hours)**

Jointly distributed random variables, independence, conditional distributions, expectation and variance, covariance and correlation, variance of sums, introduction to weak law of large numbers .

Sampling distributions: random sample, parameter and statistic, sampling distribution of sample mean and proportion, standard error, introduction to t, chi-square and F distributions.

UNIT – II **(15 Hours)**

Parameter estimation: point estimation, properties of estimators (basic idea), maximum likelihood estimation (introductory), interval estimation of mean and proportion.

Hypothesis testing: basic concepts, level of significance, p-value, large and small sample tests (mean and proportion – basic), chi-square test for goodness of fit and independence.

Reference Books

1. Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, Cengage Learning, 2015.
2. Ronald E. Walpole et al., *Probability and Statistics for Engineers and Scientists*, Pearson, 2012.
3. William Mendenhall et al., *Introduction to Probability and Statistics*, Cengage Learning, 2013.
4. Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Academic Press, 2014.

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Course Title: Miner VIII : Stochastic Processes(Minor)

Course Outcomes (COs)

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

1. Explain fundamental concepts of stochastic processes and classify different types of processes.
2. Analyze discrete-time Markov chains and compute transition probabilities and steady-state distributions.
3. Apply Poisson and birth–death processes to model real-world systems.
4. Evaluate queueing models and interpret system performance measures.

UNIT – I: Foundations of Stochastic Processes and Markov Chains (15 Hours)

Basics: Definition and types of stochastic processes; discrete and continuous time processes; state space (finite and infinite).

Markov Chains: Markov property, transition probability matrix (TPM), Chapman–Kolmogorov equations (introductory), n-step transition probabilities.

State Analysis: Classification of states – accessible, communicating, recurrent, and transient states.

UNIT – II: Poisson Processes, Queuing (15 Hours)

Poisson Process: Definition, properties (including memoryless property), real-world applications.

Continuous Systems: Introduction to birth–death processes and continuous-time Markov chains.

Queueing Theory: M/M/1 queue – characteristics, average queue length, waiting time.

Reference Books

1. Sheldon M. Ross, *Introduction to Probability Models*, Academic Press, 2014.
2. J. Medhi, *Stochastic Processes*, New Age International, 2010.
3. Allen B. Downey, *Think Stats / Think Bayes*, O'Reilly Media, 2013.
4. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006. *(for AI applications)*
5. S. Karlin and H.M. Taylor, *A First Course in Stochastic Processes*, Academic Press, 2012. *(Advanced Reference)*

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)

Course Title: Statistics Practical based on Minor VII and VIII

Practical Experiments(Minor VII).

1. Compute mean, variance, covariance, and correlation for a dataset.
2. Simulate random variables and verify properties of expectation.
3. Demonstrate Central Limit Theorem using simulation.
4. Draw random samples and compute sampling distributions.
5. Calculate standard error for sample mean and proportion.
6. Construct confidence intervals for mean and proportion.
7. Perform Maximum Likelihood Estimation (basic examples).
8. Test equality of two means using appropriate statistical tests.
9. Perform chi-square goodness-of-fit test.
10. Conduct chi-square test for independence using contingency tables.

Practical Experiments(Minor VIII)

11. Simulate discrete-time stochastic processes using random number generation.
12. Implement and visualize Markov chains using transition probability matrices.
13. Compute n-step transition probabilities for a given Markov chain.
14. Determine steady-state (stationary) distribution numerically.
15. Simulate Poisson process and verify its properties.
16. Generate inter-arrival times using exponential distribution.
17. Model and simulate birth–death processes.
18. Implement basic M/M/1 queue simulation and compute average waiting time.
19. Analyze queue performance (queue length, utilization).

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: AEC-II : Business Communication

Course Outcomes:

After completion of this course students will be able to:

1. To provide an overview of Prerequisites to Business Communication.
2. To put in use the basic mechanics of Grammar.
3. To underline the nuances of Business communication.
4. Analyze the communication process and its components (sender, message, medium, receiver, feedback) to enhance clarity and effectiveness.
5. Differentiate and apply levels and flows of communication (intrapersonal, interpersonal, organizational, mass media) within a business environment.

UNIT I **(15 Hours)**

Need and Importance of effective communication skills, Basic ways of communication (Listening, Speaking, Reading, Writing), Forms/methods of Communication (verbal-oral and written; nonverbal- Body language, facial expressions, eye contact, gestures, postures, paralinguistic features, signs, symbols, signals etc.), Communication cycle/process (sender, receiver, message, medium/channel, feedback, encoding and decoding) (Thinking, getting ideas, determining intent, selecting notes, and media, encoding, transmitting messages, decoding, receiving, perceiving, and interpreting, giving feedback, etc.), Barriers to communication (physical, mechanical, psychological, socio-cultural, linguistic, inter-personal, organizational, etc.) and techniques to overcome them.

UNIT II **(15 Hours)**

Levels of communication: importance and nature (extra-personal, intrapersonal, interpersonal, transpersonal, organizational, mass and media communication, Communication in business context (channel/flow of communication in business context: formal, informal, vertical, horizontal/lateral, crosswise, grapewine, etc.), Written Communication, the process of formal written communication, designing a message, deciding purpose, analyzing audience, organizing, selecting, arranging ideas, and preparing outlines, enveloping a message – writing, evaluating, revising, and editing. Reading and analysis of Business articles, short reports, success stories and case lets. Seven Cs of Business Writing - Completeness, Conciseness, Consideration, Concreteness, Clarity, Courtesy, Correctness.

Reference Books:

1. Communication Skills by Meenakshi Raman and Sangeeta Sharma
2. Communication Skills by Kumar and Lata
3. Business Communication by Raman and Sing
4. A Complete Course in Communication Skills by Dr. Ravi S. Sharma

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: SEC-II (T): Java Programming - II

Course Outcomes:

After completion of this course students will be able to:

1. Understand and apply Java Collections Framework concepts and multithreading mechanisms for concurrent programming.
2. Design database applications using JDBC architecture, statements, ResultSet, and CRUD operations.
3. Develop web applications using Servlets for request handling, session tracking, and database connectivity.
4. Build dynamic web pages using JSP concepts including lifecycle, implicit objects, directives, actions, and Expression Language.

Unit I **(15 Hours)**

Collections Framework : Introduction to Collection framework, Generics in Collections, List (ArrayList, LinkedList), Set (HashSet, TreeSet), Map (HashMap, TreeMap), Comparable vs Comparator, Iterator, ListIterator, Enumeration, enhanced for-loop.

Multithreading : Concept of Process and Thread, Life cycle of thread, Creating threads using Thread class and Runnable interface, Thread priorities, Running multiple threads, Synchronization.

Unit II **(15 Hours)**

Database Programming using JDBC : JDBC architecture and design, Types of JDBC drivers, DriverManager and Connection, Statement and PreparedStatement, Executing SQL statements, CRUD operations, ResultSet.

Servlets : Introduction to Servlet, Servlet lifecycle, Handling GET and POST requests, Handling data from HTML to Servlet, Database connectivity in Servlet, Session tracking (Cookies, HttpSession, URL rewriting, hidden form fields).

JSP : Introduction to JSP, JSP lifecycle, Implicit objects, JSP directives.

Reference Books:

1. Herbert Schildt - Java: The Complete Reference, McGraw-Hill Education, 11th Edition, 2019
2. Cay S. Horstmann - Core Java Volume I – Fundamentals, Pearson Education, 11th Edition, 2018
3. Bryan Basham, Kathy Sierra, Bert Bates - Head First Servlets and JSP, O'Reilly Media, 2nd Edition, 2008
4. Kogent Learning Solutions - Java 2 Enterprise Edition, Pearson Education (India), 1st Edition, 2014

B.Sc. B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course: VEC - II : Environmental Studies

Course Outcomes:
After completion of this course students will be able to:

1. Explain the scope, objectives, and multidisciplinary nature of environmental science with a focus on sustainable development.
2. Analyze the structure and functions of ecosystems and recognize their significance for conservation efforts.
3. Evaluate the importance and challenges of managing natural resources to promote sustainable living.
4. Understand the concepts of biodiversity, its importance, threats, and conservation strategies, especially in the context of the Western Ghats.
5. Identify varioustypes and sourcesof environmental pollution and assess appropriate mitigation and control measures.
6. Develop awareness and responsibility towards environmental issues and the role of individuals and society in achieving sustainability.

To be taken from Environmental Science BoS

B.Sc. Data Science
Multiple Entry and Multiple Exit Option (NEP-2020)
PART II SEM IV(Level- 5.0)
Title of course : CEP-I(P): Field work

Course Outcomes:

After completion of this course students will be able to:

1. Understand the structure and values of rural society, including joint family systems, caste and gender relations, and rural cultural practices.
2. Examine rural livelihoods through agriculture, land ownership, water management, animal husbandry, and non-farm enterprises, including the role of rural entrepreneurs and markets.
3. Analyze traditional and modern rural institutions such as self-help groups, panchayati raj institutions, local governance bodies, and their roles in decentralized planning.
4. Explore the significance of natural and public rural resources like ponds, fisheries, and community-based resource management systems.
5. Evaluate national rural development programs such as NRLM, MGNREGA, and the role of civil society and local administration in empowering rural communities.
6. Assess the impact of current flagship national schemes like Swachh Bharat, Skill India, Ayushman Bharat, Digital India, and ATMANIRBHAR Bharat on rural transformation.

Field work as per NEP 2.0 (CEP, CC), University circular enclosed