YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS
B.Sc. MATHEMATICS, STATISTICS & COMPUTER SCIENCE
FIFTH SEMESTER
ACADEMIC YEAR 2022- 23 OF 2020-23 BATCH (CBCS)

Sl. No.	Part	Subject Code	Title of the Subject	Hours/ Week	Duration of semester exams	Marks			Credits
						Internal	External	Total	
THEORY									
1	II	MS18501A/ MS18501B	Discrete Mathematics / Elementary Number theory DSE -I	4	3	40	60	100	4
2	II	MS21502A/ MS21502B	Statistical Quality Control and Reliability/Statistical Techniques in Data Warehousing and Data Mining (DSE-2)	3	3	40	60	100	3
3.	II	MS18504	Linear Algebra (Core Course-13)	4	3	40	60	100	4
4.	II	MS21503	Sampling theory, Time Series, Index Numbers and Demand Analysis (Core Course-14)	5	3	40	60	100	4
5.	II	MS18506	Java Programming (Core Course-15)	4	3	40	60	100	4
PRACTICALS									
7.	II	MS18507	Linear Algebra Lab (Core Course-13)	2	3	40	60	100	1
8.	II	MS21509	Sampling theory, Time Series, Index Numbers and Demand Analysis Lab (Core Course-14)	2	3	40	60	100	1
9.	II	MS18508	Java Programming Lab (Core Course-15)	2	3	40	60	100	1
9.	II	MS21510	R Programming Lab (GE – 4)	1+2	3	40	60	100	2
Total				**29**		360	540	900	24

Discipline Specific Elective (DSE**)** Generic Elective (GE)

DISCRETE MATHEMATICS
Discipline Specific Elective 1A

Credits : 4 **Semester: V**

Subject Code : MS18501A **No. of Lecture hours: 60**

Objective: The objective of the course is to introduce students with an introduction to lattices, Boolean algebras and fundamental concepts in graph Theory, with some of their modern applications.

Outcome:

CO1: Develop understanding of Logic Sets and Functions
CO2: Understand Boolean algebra and basic properties of Boolean algebra; able to simplify simple Boolean functions by using the basic Boolean properties.
CO3: **Develop** an understanding of how graph and tree concepts are used to solve problems arising in the computer science.
CO4: **Evaluate** and apply the fundamental concepts in graph theory.
CO5: Apply graph theory based tools in solving practical problems.

UNIT I	**12Hrs**
Relations and ordering- Types of relations- Equivalence relation	4
Partial order relations - Partially ordered sets	4
Maximal and Minimal Elements of Posets - Hasse diagrams	4

UNIT II	**12Hrs**
Lattices:	
Lattices - Properties of lattices	6
Types of Lattices – Bounded Lattice, Distributive lattice – Complemented Lattice and their Properties	6

UNIT III	**12Hrs**
Boolean algebra: Boolean algebra and its Applications	4
Boolean polynomials, Disjunctive normal form, Conjunctive normal form	4
Minimization of Boolean functions using K-Map technique	4

UNIT IV	**12Hrs**
Graph theory – I:	
Definition of a graph, Degree of vertex	4
First theorem of graph theory Paths and connection	2
Isomorphism of graphs	2
some special simple graphs	2
Trees and their properties	2

UNIT V	**12Hrs**
Graph theory-II:	
Planar graphs, Euler's formula	3
Euler graphs	3
Hamiltonian graphs	3
Chromatic numbers (Only Problems)	3

ESSENTIAL READING:

1. Trembly J.P. and Manohar. R 2005 **Discrete Mathematical Structures with Applications to Computer Science** Tata Mc Graw Hill Publishing Company Ltd, New Delhi (For Unit I – III)
2. Joe. L.Mott & Abrham Kandel, Theodore P. Baker 2007 **Discrete Mathematics for Computer scientists** and **Mathematicians** 2nd Edition, PHI New Delhi (For Units IV & V)

ELEMENTARY NUMBER THEORY
Discipline Specific Elective 1B

Credits : 4 **Semester: V**

Subject Code : MS18501B **No. of Lecture hours: 60**

Objective: To study of the basic structure and properties of integers.

Outcome:

CO1: Express the concepts and results of Number Theory.
CO2: **Demonstrate** knowledge and understanding of topics including divisibility, prime numbers, congruences, Diophantine equations.
CO3: **Identify** methods and techniques used in number theory.
CO4: **Solve** challenging problems in Number Theory.
CO5: Develop a deeper conceptual understanding of the theoretical basis of number theory and cryptography.

UNIT-I	**12Hrs**
Early Number Theory	
Divisibility-The Division algorithm	4
Euclid' algorithm- The Diophantine equation ax + by = c	4
Greatest Common Divisor - Properties of G.C.D.	4

UNIT-II	**12Hrs**
Primes – Fundamental theorem of Arithmetic.	3
The sieve of Eratosthenes	3
Goldbach Conjecture	3
Congruences – Properties- Applications of Congruences	3

UNIT-III	**12Hrs**
Linear Congruences - Solutions of Congruences	4
Fermat's theorem and its Applications	4
Wilson's theorem and its Applications	4

UNIT IV	**12Hrs**
The functions τ and σ	4
The Mobius inversion Formula	4
The greatest integer Function	4

UNIT V	**12Hrs**
Euler Totient function $\phi(n)$	3
Euler's Theorem	2
Some properties of The Phi -function	4
An Application to cryptography	3

ESSENTIAL READING:

1. David M. Burton 2004 **Elementary Number Theory** Universal Book Stall New Delhi

STATISTICAL QUALITY CONTROL AND RELIABILITY
DISCIPLINE SPECIFIC ELECTIVE II (A)

Credits : 3 **Semester: V**

Subject Code : MS21502A **No. of Lecture hours: 45**

Objectives: The statistical quality control (SQC) is used to achieve quality in production and service organizations, using adequate statistical techniques. Different quality characteristics are measured and compared with pre-determined specifications, the quality norms. Reliability is applied in engineering to prevent or to reduce the likelihood or frequency of failures. To identify and correct the causes of failures that occur despite the efforts to prevent them.

Outcome:

CO1: **Analyze** the concepts of quality control, chance and assignable causes of variation, control charts for variables and attributes.
CO2: **Classify tolerance** limits, specification limits and process capability limits.
CO3: To **Understand** the concepts of process capability and tolerance limits in SQC.
CO4: **To Apply** single and double sampling plans and to assess the risks.
CO5: **Analyze** statistical experiments leading to reliability modeling.

UNIT-I	**9 Hrs**
STATISTICAL QUALITY CONTROL:	
Importance of SQC in industry. Dimensions of quality	1
Statistical basis of Shewart control charts.	1
Construction of control charts for variables (mean, range, and standard deviation) and their interpretations	7

UNIT-II	**9 Hrs**
Construction of control charts for attribute sp chart	3
np chart fixed and varying sample sizes, and	3
c-charts with fixed and varying sample sizes and their interpretation.	3

UNIT-III	**9Hrs**
Construction of control charts for natural tolerance limits	3
and specification limits,	3
process capability index and modified control charts.	3

UNIT-IV	**9 Hrs**
Acceptance sampling plans:	
Concept of AQL and LTPD.	1
Producer's risk and consumer's risk.	1
Single and Double sampling plans for attributes and their OC and ASN functions.	1
Design of single and double sampling plans for attributes using Binomial and Poisson distributions.	5
Construction of OC and ASN functions.	1

UNIT-V	**9 Hrs**
Reliability: Introduction. Hazard function	1
Exponential distribution as life model, its memory-less property.	1
Reliability function and its estimation.	3
System reliability-series, parallel and k out of N systems and their reliabilities with simple examples.	4

REFERENCE BOOKS:

1. D. C. Montgomary. 2007 **Introduction to Statistical Quality Control** by. Wiley.
2. S. K. Sinha 2010 **Reliability and Life Testing** by. Wiley Eastern. New Delhi.
3. L. S. Srinath. **Reliability Engineering** by Affiliated East-West Press.
4. R. C. Gupta: **Statistical Quality control**.
5. Parimal Mukhopadhyay 2007 **Applied Statistics**. New Central Book Agency.

STATISTICAL TECHNIQUES IN DATA WAREHOUSING AND DATA MINING
DISCIPLINE SPECIFIC ELECTIVE II (B)

Credits : 3 **Semester: V**

Subject Code : MS21502B **No. of Lecture hours: 45**

Objective: Data mining is the process of uncovering patterns and finding anomalies and relationships in large datasets that can be used to make predictions about future trends. The main purpose of data mining is extracting valuable information from available data.

Outcomes:

CO1: To **Understand** Data Warehouse fundamentals, Data Mining Principles
CO2: To **Compare** Data Mining and KDD process.
CO3: To Compare and evaluate different data mining techniques like clustering and association rule mining
CO4: **To Demonstrate** classification, k – nearest neighborhood techniques used in making better decisions.
CO5: To **Design** data warehouse with dimensional modeling and apply OLAP and OLTP operations.

UNIT – I **9 Hrs**

Data mining Introduction: Introduction to Data mining, The nature of Data sets,
Types of structure. 3
Models and patterns, Data mining Tasks, components of data mining algorithms. 3
The Interacting roles of Statistics and Data mining, Dredging, snooping and fishing. 3

UNIT – II **9 Hrs**

Definitions, KDD vs Data mining
DBMS vs DM, other related areas, DM Techniques 3
other mining problems, Issues and challenges in Data mining. 3
Social implication of Data Mining. 3

UNIT-III **9 Hrs**

Association Rules: What is an association rule, large item sets
Methods to discover association rules; Apriori Algorithm, Partition Algorithm 3
Association Algorithms: Dynamic Item Set Counting Algorithm,
FP Tree growth algorithm 3
Clustering Algorithms: Introduction, Similarity and distance measures, outliers,
Clustering Paradigm, K-Medoid Algorithm, DBSCAN 3

UNIT-IV **9 Hrs**

Classification: Introduction, Issues in classification, Problem definition,
Evaluation of classifiers
Decision tree construction, Algorithm for decision tree induction, 3
Naives – Bayes classifier, Bayesian Belief Networks, K- Nearest neighbor. 3
Decision tree Algorithms: Introduction, Pruning technique. 3

UNIT-V	**9 Hrs**
Data Warehousing: Introduction, traditional databases, Operational data.	3
Functions of data transformation. Summarization, Denormalization, Partitioning.	3
OLAP with types, OLTP, Web search engines and its problems.	3

REFERENCE BOOKS:

1. David Hand, Heikki Manila and Padhraic Smyth (2012): Principles of Data Mining, PHI, New Delhi, (Text Book: Ch. 1, Ch. 2, Ch. 10.6)
2. Arun K Pujari (2013): Data Mining Techniques, University Press India private Ltd. Third Edition. (T.B-2: (T.B.2: Ch 5.4, 5.8, Ch. 6.18).
3. Margaret H. Dunham: Data Mining - introductory and Advanced Topics, Pearson Publication.

LINEAR ALGEBRA
(Core Course-13)

Credits : 4 **Semester: V**

Subject Code : MS18504 **No. of Lecture hours: 60**

Objectives: The objective of this course is to present a user friendly introduction to linear algebra and its many applications.

Outcome:

CO1: **Construct** mathematical arguments that relate to the study of introductory linear algebra.
CO2: **Solve** the characteristic polynomial, eigenvectors, eigen values.
CO3: **Analyze** finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces.
CO4: **Use** the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism.
CO5: **Explain** orthogonality on vector spaces and compute inner products and, including Gram-Schmidt orthogonalization.

UNIT – I **12Hrs**

Matrices –I:

The Rank of a Matrix and Matrix Inverses	4
Echelon form and normal form of matrices	4
Elementary Matrix Operations and Elementary Matrices	4

UNIT – II **12Hrs**

Matrices II

Systems of Linear Equations - Consistency and in Consistency of Equations. (Only Problems.)	4
Eigen values and Eigenvectors	4
Cayley-Hamilton Theorem. (Without proof) Problems	4

UNIT III **12Hrs**

Vector Spaces:

General properties of Vector Spaces	3
Vector Subspaces - Algebra of subspaces	3
Linear Span- Linear sum of two subspaces	3
Linear Dependence and Linear Independence of vectors	3

UNIT IV **12Hrs**

Basis of a vector Space - Finite Dimensional vector Spaces. Dimension of a vector Space - Dimension of a vector subspace	4

Linear Transformations:

Linear Transformations – Linear Operators	4
Range and Null Spaces of a Linear Transformation	
Rank and Nullity of Linear Transformation	4

UNIT V	**12Hrs**
Inner Product Spaces:	
Euclidean and Unitary spaces	4
Norm or length of a vector- Triangle inequality	
Schwarz's inequality	4
Orthogonality - Orthonormal set- Complete Orthonormal set	
The Gram-Schmidt Orthogonalization Process	4

ESSENTIAL READING

1. David C Lay 2012 **Linear algebra with Applications** Fourth edition Pearson
2. J.N Sharma and A.R. Vasistha, 2010 **Linear Algebra** Krishna Prakashan Mandir, Meerut. (For Units III, IV, V)

SUGGESTED READINGS:

1. John B. Fraleigh 2005 **A First Course in Abstract Algebra** by, published by Narosa Publishing House New Delhi. (For Units I & II)
2. N. Jacobson, 1980 **Basic Algebra**, Vols. I & II W.H. Freeman, (also published by Hindustan Publishing Company).
3. Shantinarayan & P.K.Mittal 2007 A Text Book of Modern Abstract Algebra, S. Chand & Co. New Delhi.

SAMPLING THEORY, TIME SERIES, INDEX NUMBERS AND DEMAND ANALYSIS
(Core Course-14)

Credits: 4 **Semester: V**

Subject Code : MS21503 **No. of Lecture hours: 75**

Objectives: The objective of sample survey is to ask scientific questions from the perspective of the **survey** methodology to be used to collect data. To identify the nature of the phenomenon represented by the sequence of observations and forecasting future values of the **time series** variable. Demand Analysis aids in forecasting sales and revenues. The **purpose** of **index numbers** is to provide information regarding the changes in the real wages of the workers.

Outcome:

CO1: To design and implement **surveys** with the simple random sampling technique.

CO2: To estimate sample size for different sampling designs like systematic and stratified sampling to estimate population parameters.

CO3: To use special statistical methods to reveal hidden patterns of the data within each organization.

CO4: To understand the concepts of cost, nature of production and its relationship of business operations.

CO5: To interpret indexes to identify trends in a data set and use the consumer price index to determine the purchasing power of the dollar and to compute real income.

UNIT-I **15Hrs**

SAMPLE SURVEYS:

Concepts of population, sample, sampling unit, parameter, statistic, sample frame and standard error.	1
Principle steps in sample surveys	1
Need for sampling, census versus sample surveys, sampling and non-sampling errors	1
Sources and treatment of non-sampling errors, advantages and limitations of sampling.	1
Types of sampling: Subjective, probability and mixed sampling methods	1
Methods of drawing random samples with and without replacement	2
Estimates of population mean, total, and proportion, their variances	3
and the estimates of variances in simple random sampling with and without replacements	3
Advantages and Disadvantage of simple random sampling (Theorems & Proofs)	2

UNIT-II **15Hrs**

STRATIFIED RANDOM SAMPLING:

Estimates of population mean, total, their variances and the estimates of variances by Stratified random sampling with proportional and Neyman allocation	4
Comparison of efficiency with simple random sampling	2
Advantages and disadvantages of Stratified random sampling. (Theorems & Proofs)	1

SYSTEMATIC RANDOM SAMPLING:

Estimates of population mean, total, their variances and the estimates of variances by Systematic Random Sampling when N = nk.	3
Comparison of efficiency with Simple random sampling and Stratified random sampling.	4
Advantages and disadvantages of Systematic sampling. (Theorems & Proofs)	1

UNIT-III **15Hrs**

TIME SERIES:

Time series and its components with illustrations	1
Additive, multiplicative and mixed models in time series	1
Determination of trend by least squares and moving average methods.	3
Growth curves and their fitting with reference to Modified exponential, Gompertz and Logistic curves.	5
Determination of seasonal indices by simple averages, ratio to moving average, ratio to trend and link relative methods	5

UNIT-IV **15Hrs**

DEMAND ANALYSIS:

Introduction, Demand and Supply, price elasticity of supply and demand.	1
Methods of determining demand and supply curves	2
Leontief's, Pigous's methods of determining demand curve from time series data, limitations of these methods.	4
Pigous's method from time series data	3
Pareto's law of income distribution	3
Curves of concentration in demand analysis (Lorenz curve)	2

UNIT-V **15Hrs**

INDEX NUMBERS:

Concept, construction, problems involved in the construction of index numbers	1
Uses and limitations of simple and weighted index numbers.	1
Laspeyer's, Paasche's and Fisher's index number.	3
Criterion of a good index numbers	1
Fisher's index number as an ideal index number	1
Fixed and chain base index numbers.	3
Cost of living index numbers and wholesale price index numbers.	2
Base shifting, Splicing and Deflation of index numbers.	3

ESSENTIAL READING:

1. Gupta S.C. Kapoor. V.K. 2015 **Fundamentals of Applied Statistics** Sultan Chand & Sons**,** New Delhi.

SUGGESTED READING:

1. Parimal Mukhopadhyay **Applied Statistics** New Delhi: New Central Book Agency.
2. Daroga singh & F.S. Chowdhary **Theory & Analysis of Sample Survey designs** New Delhi: Wiley Eastern India.
3. Cochran, **Sampling Techniques** by Wiley Eastern India, New Delhi.
4. A.M. Goon, M.K. Gupta, B. Dasgupta an outline of Statistical Theory Vol II Calcutta17: World Press Private Ltd.,

JAVA PROGRAMMING
(Core Course-15)

Credits: 4 **Semester: V**

Subject Code: MS18506 **No. of Lecture Hours: 60**

Objective: Java has now emerged as the language of choice of the world computing community due to its simplicity, portability and security.

Outcome:

CO1: Understand and identify basic computer network topologies and protocols and explain Data Communication System components and functions of each layer in OSI model and its protocols.
CO2: Classify different error detecting techniques.
CO3: Create skills of sub-netting and routing mechanisms.
CO4: Identify different internetworking devices
CO5: Compare different OSI upper layers

UNIT – I **12Hrs**

Java Evolution

1. Java History, Java Features, How java differs from C and C++ 1
2. Java and internet, java and world wide web, web browsers 2
3. Hardware and software requirements, java support systems, java environment 1

Overview of java language, constants, variables and data types

4. Simple java program, An application with two classes, java program structure 2
5. Java tokens, java statements, implementing java program 2
6. Java virtual machine, Command line arguments 1
7. Constants, Variables, Data types, declaration of variables, Giving values to variables, scope of variables, symbolic constants, typecasting 3

UNIT – II **12Hrs**

Operators and expressions

1. Types of operators, arithmetic expressions, Evaluation of expressions, Precedence and associativity of operators 2

Decision Making and Branching

2. If, if-else, nesting of if-else, else if ladder, switch statement, ?: operator 2

Decision Making and looping

3. While, do while, for, jumps in loops, labeled loops 2

Classes, Objects and Methods

4. Introduction, defining a class, filed declarations, method declarations, creating objects, accessing class members, constructors, method overloading, Static members, Inheritance and types of inheritance, overriding of methods, Final variables, methods and classes, Finalizer method, Abstract methods and classes, visibility control 6

UNIT – III **12Hrs**

Arrays, strings and vectors

1. Introduction, one-dimensional arrays, Creating an array, Two-dimensional Arrays, Strings, string buffers, vectors, wrapper classes, Enumerated types 6

Interfaces and packages

2. Introduction, defining and extending interfaces, implementing interfaces, accessing interface variables 2
3. Java API packages, using system packages, Naming conventions,
4. creating packages, Accessing a package, using a package, adding a class to a package, hiding classes and static import 4

UNIT – IV **12Hrs**

Multithreaded programming

1. Introduction, Creating threads, Extending a thread class, Stopping and blocking a thread 2
2. Thread life cycle 1
3. Using Thread methods, Thread Exceptions, Thread priority and synchronization Implementing the Runnable interface 2

Managing errors and exceptions

4. Introduction, types of errors, Exceptions, Syntax of exception handling, Multiple catch statements, using finally statement, throwing our own exceptions 3

Applet Programming

5. Introduction, how applet differ from application, preparing to write applets, building applet code 2
6. Applet life cycle, Creating an executable applet, Designing a web page, applet tag, Adding applet to HTML file, Running the applet, passing parameters to applet, Aligning the display, More about HTML tags, Displaying numerical values and getting input from user. 2

UNIT– V **12Hrs**

Applets working with graphics 2

Event Handling

1. Two event handling mechanisms, The delegation event model, Event classes (Action, Mouse, Window, Item, Focus events) 3
2. Sources of events, Event listener interfaces (Action listener, Mouse listener, Mouse Motion listener, Focus Listener, Window listener) 2

Abstract Window Tool kit

3. Labels, Buttons, Check boxes, Radio buttons, Text fields, Text Areas, Choice, Lists, Layouts (Flow, Border and Grid layouts) 5

ESSENTIAL READING

1. Schin Malhotra, Sourab Choudhary 2017 **Programming in JAVA**, Oxford University Press.

SUGGESTED READING

1. CAMPINE WALRAH, HUML, 1999 The Java Tutorial Continued, Sun Micro Systems.
2. Naughton Patrick, Schildt Herbert, **The complete Reference Java 2,** Third Edition Tata McGraw Hill Publications.
3. Balaguruswamy E, Programming with Java, Third Edition (Units I, II, III & IV) Tata McGraw Hill Publications.

LINEAR ALGEBRA PRACTICALS
(Core Course-13)

Credits : 1 **Semester : V**

Subject Code : MS18507 **No. of Practical hours :30**

LIST OF PRACTICALS

1-2. Linear Combinations.
3-4. Linear Dependence and Linear Independence-
5-6. Range and Null Spaces of a Linear Transformation – Rank and Nullity of a Linear Transformation-
7. The Matrix Representation of a Linear Transformation-
8. Rank of a matrix- Inverse of a matrix
9- 10. System of linear equations.
11 - 12. Eigen value and eigen vectors.
13 -14. Cayley Hamilton theorem.
15. The Gram-Schmidt Orthogonalization Process and Orthogonal Complements.

SAMPLING THEORY, TIME SERIES, INDEX NUMBERS AND DEMAND ANALYSIS PRACTICAL
(Core Course-14)

Credits : 1 **Semester: V**

Subject Code : MS21509 **No. of Practical hours :30**

Objective: To draw appropriate sample and interpret the result. To apply of index numbers. To estimate the different components of time series analysis.

Outcome: Students will be able to estimate mean and variances for different sampling techniques, measure the tend using different techniques, calculate the index numbers and interpret.

LIST OF PRACTICALS

Sampling Techniques:

Estimation of population mean, population total, and variance of these estimates by

1. Simple random sampling with and without replacement. Comparison between SRSWR & SRSWOR.
2. Stratified random sampling with proportional & optimum allocations. Comparison between proportional and optimum allocation with SRSWOR.
3. Systematic sampling with N = nk. Comparison of systematic sampling with Stratified and SRSWOR.

Time Series Analysis:

4. Measurement of trend by methods of Least squares and moving averages.
5. Measurement of trend by methods of Least squares and moving averages using Office Automation.
6. Determination of seasonal indices by methods of Ratio to moving averages, Ratio to trend and Link relatives.
7. Determination of seasonal indices by methods of Ratio to moving averages, Ratio to trend and Link relatives using Office Automation.

Demand Analysis:

8. Construction of Lorenz curve.
9. Fitting of Pareto law to an income data.
10. Construction of Lorenz curve using Office Automation.

Index Numbers:

11. Computation of simple and all weighted numbers.
12. Computation of reversal tests.
13. Construction of cost of living index number and wholesale index number.
14. Construction of fixed base and chain base index numbers.
15. Base shifting, Splicing and Deflation of Index numbers.
    Computation of all weighted indices, cost living index number, Base shifting, Splicing and Deflation using Office Automation.

JAVA PROGRAMMING PRACTICAL
(Core Course-15)

Credits : 1 **Semester: V**

Subject Code : MS18508 **No. of Practical hours: 30**

List of Programs

1. Write a Java Program to find largest of three numbers using command line arguments.
2. Write a Java Program with two classes to find out the area of a room.
3. Write a Java Program to perform arithmetic operations using Switch case.
4. Write a Java Program for Constructor Overloading.
5. Write a Java Program for Method Overloading.
6. Write a Java Program for Method Overriding.
7. Write a Java Program to illustrate this() method.
8. Write a Java Program to find factorial of a given number using recursion.
9. Write a Java Program, which illustrates break, and continue.
10. Write a Java Program to find sum of elements of an array.
11. Write a Java Program for Bubble sort.
12. Write a Java Program for addition and subtraction of two matrices.
13. Write a Java Program for multiplication of two matrices.
14. Write a Java Program, which illustrates Static Variables and Static methods.
15. Write a Java Program for single level inheritance.
16. Write a Java Program for multi-level inheritance.
17. Write a Java Program for Hierarchical inheritance.
18. Write a Java Program, which illustrates Dynamic Polymorphism.
20. Write a Java Program, which illustrates super keyword with methods.
21. Write a Java Program, which illustrates super of methods.
22. Write a Java Program, which illustrates final keyword with variables.
23. Write a Java Program, which illustrates final keyword with methods.
24. Write a Java Program, which illustrates abstract classes.
25. Write a Java Program, which illustrates indexOf(), charAt(), substring(), length(), to UpperCase(),toLowerCase(), trim(), equals() and equalsIgnoreCase() methods.
26. Write a Java Program, which illustrates Multiple inheritance.
27. Write a Java Program, which illustrates creation and implementation of packages.
28. Write a Java Program, which illustrates Exception handling with multiple catch blocks.
29. Write a Java Program, which illustrates Exception handling with catch and finally blocks.
30. Write a Java Program, which illustrates creation of threads by extending Thread class.
31. Write a Java Program, which illustrates creation of threads by implementing Runnable interface.
32. Write a Java program, which illustrates sequence of events in Applets.
33. Write a Java Program, which illustrates passing parameters to applets.
34. Write a java program, which illustrates Labels.
35. Write a Java Program, which illustrates Buttons.
36. Write a Java Program, which illustrates check boxes.
37. Write a Java Program, which illustrates radio buttons.
38. Write a Java Program, which illustrates choice list.
39. Write a Java Program, which illustrates lists.
40. Write a Java Program to draw lines and rectangles.
41. Write a Java Program to draw polygons.

R PROGRAMMING PRACTICAL
(GE - 4)

Credits: 2 **Semester: V**

Subject Code: MS21510 **No. of Lecture Hours: 45**

Objectives: To learn the statistical programming language R and to use it to manipulate data. To reshape data to support different analysis and to explore data from a variety of sources by building inferential models, generating charts, graphs and other data representations.

Outcome: Students will be able to
CO1: **Understand** basic concept of R.
CO2: **Demonstrate** programming concepts and data structures in R.
CO3: **Analyze** large problem by sub dividing it into smaller components using functions
CO4: **Choose** an appropriate graphic for analysis and analyze data using summary statistics.
CO5: **Choose** the type of regression based on data set.

UNIT – I **9 Hrs**

1. Introduction to R: What is R, Features of R, Simple Math, R as a Calculator **Reading and Getting Data into R:** Reading Data, Readinga File of Data from a Disk, Reading Bigger Data Files, The read. csv() Command, Alternative Commands for Reading Data in R Saving Data Files to Disk and Reading Data from the Disk.

UNIT – II **9 Hrs**

Data objects in R, Series and Control Statements: Assignment, Modes, Operators, Basic Functions, Generating Data sets, Control Structures **Vectors:** Definition, Declaration, Generating, Indexing, Naming, Adding and Removing Elements,

Operations on Vectors: Recycling, Special Operators, Functions for Vectors Missing Values, Null Values, Filtering and Sub setting,

Data Structures in R-Arrays: Creating Arrays, Dimensions and Naming, Indexing and Naming, Functions on Arrays

UNIT – III **9 Hrs**

Matrices: Creating Matrices, Adding Rows/Columns, Removing Rows/Columns Reshaping Operations, Special Functions **Lists:** Creating, Naming, Accessing Elements, Adding, Removing, Special Functions, Recursive Lists

Data Frames: Creating, Naming, Accessing, Adding, Removing, Special Functions, Merging Exercises

UNIT-IV **9 Hrs**

Descriptive Statistics: Introduction, Descriptive Statistics, Central Tendency Variability, Mean, Median, Range, Variance, Summary, correlation, covariance, Exercises

Graphics: Introduction, Types, Packages, Basic Graph, Histograms, Bar and Pie chart, Line chart, scatter plot.

UNIT – V **9 Hrs**

Distributions: Normal, binomial, Poisson Parametric techniques: One sample t test, Independent T Test, dependant test, Anova **Linear Regression:** Inferential Statistics, Types of Learning, Linear Regression, Simple Linear Regression, Coefficients, Confidence Interval, RSE, R2 score

ESSENTIAL READING

1. Data Analytics with R by Bharati Motwani, Wiley publication
2. Cotton, Richard. 2013. **Learning R**. USA: O′Reilly

SUGGESTED READING

1. Matlof, Norman. 2011. **The Art of R Programming.** 1st Edition. San Francisco: No Starch Press.
2. Purohi, Sudha G. Gore, Sharad D. and Deshmukh, Shailaja R. 2015. **Statistics using R. 2nd** Edition. New Delhi: Narosa Publishing House.

YEAR-WISE AND SEMESTER-WISE DISTRIBUTION OF SUBJECTS B.Sc. MATHEMATICS, STATISTICS & COMPUTER SCIENCE SIXTH SEMESTER ACADEMIC YEAR 2022- 23 OF 2020-23 BATCH (CBCS)									
Sl. No.	**Part**	**Subject Code**	**Title of the Subject**	**Hours/ Week**	**Duration of semester exams**	**Marks**			**Credits**
						Internal	**External**	**Total**	
THEORY									
1	II	MS21601A/ MS21601B	Computer Networks / Software Engineering (DSE – 3)	3	3	40	60	100	3
2	II	MS21602	Functions of a Complex Variable (Core course - 16)	4	3	40	60	100	4
3	II	MS21603	Design of Experiments, Vital Statistics, Official Statistics and Business Forecasting (Core Course-17)	4	3	40	60	100	4
4	II	BS21604	Python Programming (Core Course - 18)	4	3	40	60	100	4
PRACTICALS									
5	II	MS21605	Design of Experiments & Vital Statistics Lab (Core Course-17)	2	3	40	60	100	1
6	II	BS21606	Python Programming Lab (Core Course - 18)	2	3	40	60	100	1
7	II	MS21607	Project (DSE – IV)	10	3	40	60	100	4
Total				**29**		280	420	700	**21**

Discipline Specific Elective (DSE**)**

COMPUTER NETWORKS
Discipline Specific Elective – III A

Credits: 3 **Semester : VI**

Subject Code: MS21601A **No. of Lecture Hours: 45**

Objectives:
- To get familiarize with fundamental concepts of computer network.
- To gain expertise in various layers of the TCP/IP model.

Outcome:

CO1: **Understand** and **identify** basic computer network topologies and protocols and explain Data Communication System components and functions of each layer in OSI model and its protocols.
CO2: **Classify** different error detecting techniques.
CO3: **Create** skills of sub-netting and routing mechanisms.
CO4: **Identify** different internetworking devices.
CO5: **Compare** different OSI upper layers.

UNIT-I	**9 Hrs**
Introduction: Data Communications components, line configuration and topologies	3
Transmission mode, categories of network	1
ISO reference models - Layered architecture	2
Functions of layers TCP / IP reference model	
Transmission Media-Guided media, Coaxial cable, optical fiber	2
Unguided media satellite communication and cellular telephony	1

UNIT-II	**9 Hrs**
Multiplexing: Frequency-division multiplexing, Time Division multiplexing	3
data link layer - Error detection – VRC, LRC, CRC, checksum	
Error correction – Haming code, Burst error correction	2
Line discipline – ENQ/ ACK, poll / select	
Flow control – Stop – and - wait, sliding window	2
Error control - stop and wait ARQ,	
sliding window ARQ go back n ARQ – reject ARQ	2

UNIT-III	**9 Hrs**
LOCAL AREA NETWORKS:	
Introduction to IEEE 802, Ethernet / CSMA/CD, implementation, token ring	3
token passing implementation.	3
Switching: circuit Switching, packet Switching, message Switching	3

UNIT-IV	**9 Hrs**
NETWORK AND INTERNETWORKING DEVICES – I:.	
Repeaters, bridgers, routers, gateways	4
Brouters, switches, distance vector routing algorithm, link – state routing algorithm.	5

UNIT-V **9 Hrs**

TRANSPORT LAYER:

Duties of transport layer, connection	4
Upper OSI layers, session layer, presentation layer, application layer	5

ESSENTIAL READING

1. Forouzan, Beharouz A. 2011. **Data Communications and Networking**. 4th Edition. New Delhi: Tata McGraw Hill.
2. Tanenbaum, Andrew S. 2008. **Computer Networks**. 4th Edition. New Delhi: Pearson Education.

SOFTWARE ENGINEERING
Discipline Specific Elective – III B

Credits: 3 **Semester: VI**

Subject Code: MS21601B **No. of Lecture Hours: 45**

Objective: Basic knowledge and understanding of the analysis and design of complex systems. To produce efficient, reliable, robust, and cost-effective software solutions

Outcome:

CO1: Explain engineering through various process models.
CO2: Identify analyze Requirements, Object Oriented and various modeling's.
CO3: Categorize design and architecture.
CO4: Classify Components, golden rules and design evaluation.
CO5: Understand testing techniques to evaluate quality metrics.

UNIT I **9 Hrs**

Examples test series – First cycle – Second cycle – Subsequent cycles.
Objectives and limits of testing. 3
Testing in software development process
Planning stage, Design Stage, Glass box code testing, Regression testing, Black box testing. 3
Software Errors: Reporting and analyzing bugs
Problem report contents – Characteristics-
Analysis of reproducible bug - Tactics for analyzing a reproducible bug – Making a bug reproducible. 3

UNIT II **9 Hrs**

Problem tracking systems – Objectives.
tasks Overview – Users – Mechanics – further thoughts on problem reporting. 3
Test case design – Characteristics of a good test
Equivalence classes and boundary values
Visible state transitions, race conditions 3
load testing – Error guessing –
Function equivalence testing - Regression testing – Executing the tests. 3

UNIT III **9 Hrs**

Building a software testing strategy 2
Establishing a software testing methodology 2
Determining software testing techniques 2
Eleven steps for software testing 2
Over view
Assess project management. 1

UNIT IV **9 Hrs**

Develop test plan 2
Requirement phase testing 2
Design phase testing 2
Program phase testing 1
test execution 1
Acceptance testing. 1

UNIT V	**9 Hrs**
Test software changes: Software maintenance – Definition	1
maintenance Characteristics – Maintainability	2
maintenance tasks – side effects	1
reverse engineering and reengineering.	2
Software Configuration management - Configuration items	1
SCM process – Version Control – Change control	1
Configuration audit – Status reporting.	1

ESSENTIAL BOOKS:

1. CEM KANER. JACK FALK, HUNG QUOCNGUYUN – Testing computer software, COMDEX 1998.
2. WILLIAM E. PERRY Effective Methods for software testing, Wiley 2000.
3. ROGER S. PREESS MAN - software engineering – A Practitioners Approach- Mc Graw.

FUNCTIONS OF A COMPLEX VARIABLE
(Core course - 16)

Credits : 4 **Semester: VI**

Subject Code : MS21602 **No. of Lecture hours: 60**

Objectives: The objective of this course is to give the concepts of analytical functions and their expansions and complex integration through residue calculus and conformal mapping.

Outcome:

CO1: **Represent** complex numbers algebraically and geometrically, define and analyze limits and continuity for complex functions as well as consequences of continuity.

CO2: **Apply** the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.

CO3: **Analyze** sequences and series of analytic functions and types of convergence.

CO4: **Solve** complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula.

CO5: **Classify** singularities and poles, find residues and evaluate complex integrals using the residue theorem. Represent functions as Taylor, power and Laurent series.

UNIT-I **12Hrs**

Analytic Functions:

Definition of Limit of a function – Continuity	1
Proof of Cauchy-Riemann Equations	4
Cauchy–Riemann Equations in Polar form	4
Harmonic functions – Construction of analytic functions Milne –Thomson's method	3

UNIT-II **12Hrs**

Expansion of functions as a Taylor's series–proof of Taylor's theorem- problems	6
Expansion of functions as a Laurent's series–proof of Laurent's theorem- problems	6

UNIT-III **12Hrs**

Complex Integration:

Cauchy's theorem – Extension of Cauchy's theorem	4
Cauchy's Integral Formula-Problems	4
Cauchy's Integral Formula to multiply connected regions	4

UNIT IV **12Hrs**

Cauchy's Integral Formula for the first order and Higher order derivatives of an analytic function.	4
Simple problems on complex integration	4
Singularities and Calculus of residues-Definition of various types of singularities	4

UNIT-V	**12Hrs**
Definition of residue at pole –examples	3
Cauchy's residue theorem –problems	3
Residue at a pole of order (m>1) Contour integration	3
Evaluation of integrals of the type	3

(i) $\int_0^{2\pi} f(\sin\theta,\cos\theta)d\theta$ (ii) $\int_0^{\infty} f(z)dz$

ESSENTIAL READING:

1. Theodore W. *Gamelin* 2001 ***Complex Analysis*.** Spriger International Edition

SUGGESTED READINGS

1. J. N. Sharma 2013 **Functions of a Complex Variable** Krishna Prakashan Media Pvt. Ltd. Meerut.
2. Shantinarayan, 2001 **Theory of Functions of a Complex Variable** S.Chand Company Ltd New Delhi.
3. Iyengar T.K.V.B. Krishna Gandhi, Ranganatham, Prasad M.V.S.S.N. 2009 **Engineering Mathematics Vol. III** S. Chand & co New Delhi.

DESIGN OF EXPERIMENTS, VITAL STATISTICS, OFFICIAL STATISTICS AND BUSINESS FORECASTING
(Core Course-17)

Credits : 4 **Semester: VI**

Subject Code : MS21603 **No. of Lecture hours: 60**

Objectives: Design of Experiments is a framework which helps to decide which course of action has to be taken. Vital Statistics is used in determining the number of births, deaths, marriages and divorces that occur within the nation. Official statistics provide a picture of a country or different phenomena. Business forecasting helps to plan the resources in a more economical manner and propagate optimum utilization of resources.

Outcome:

CO1: Compare the pairs of treatment means using different methods.
CO2: Learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain conclusions
CO3: To understand, Organize, manage and present data.
CO4: Analyze the birth, death and fertility rate of population.
CO5: To determine growth rate and reproductive rate of population.

UNIT-I **12Hrs**

ANALYSIS OF VARIANCE:

Concept of Gauss- Markoff linear model with examples	1
Statement of Cochran's theorem	1
ANOVA – one-way and two-way classifications with one observation per cell	4
Exception of various sum of squares, Statistical analysis,	2
Importance and applications of design of experiments.	1

PRINCIPLES OF EXPERIMENTATION:

Analysis of Completely Randomized Design (C.R.D)	3

UNIT-II **12Hrs**

Randomized Block Design (R.B.D)	5
Latin Square Design (L.S.D.) including one missing observation.	5
Expectation of various sum of squares.	1
Comparison of the efficiencies of above designs.	1

UNIT-III **12Hrs**

OFFICIAL STATISTICS:

Functions and organization of CSO and NSSO.	2
Agricultural Statistics, area and yield statistics.	2
National income and its computation, utility and difficulties in estimation of national income.	2

BUSINESS FORECASTING:

Role of forecasting in Business, steps in forecasting, Methods of forecasting.	2
Choice of a method of forecasting.	2
Theories of Business Forecasting, Cautions while Forecasting Techniques.	2

UNIT-IV	**12Hrs**
VITAL STATISTICS - I:	
Introduction, Definition and uses of vital Statistics.	3
Sources of Vital Statistics, registration method and census method.	3
Rates and Ratios, Crude death rates, age specific death rate, standardized death rates	3
crude birth rate, age specific fertility rate, general fertility rate, total fertility rate.	3

UNIT-V	**12Hrs**
VITAL STATISTICS-II:	
Measurement of population growth.	3
Crude rate of natural increase – Pearl's Vital Index.	3
Gross Reproductive rate & Net Reproductive rate.	3
Life tables, Construction and uses of Life tables and Abridged Life tables.	3

ESSENTIAL READING:

1. Gupta S.C. and Kapoor V.K. 2015 **Fundamentals of Applied Statistics** New Delhi: Sultan Chand & Sons

SUGGESTED READING

1. Parimal Mukhopadhyay **Applied Statistics** New Delhi: New Central Book Agency.
2. B. L. Agarwal2005 **Basics Statistics** New Delhi: New Age publications India.

PYTHON PROGRAMMING
(Core Course - 18)

Credits: 4 **Semester: VI**

Subject Code: BS21604 **No. of Lecture Hours: 60**

Objectives:

- Python is an object-oriented scripting language, runs on almost any operating system or hardware platform.
- Python offers an easy syntax compared to Perl and the Unix/Linux "shell languages" and most people find it easier to learn and maintain.

Outcome:

CO1: Demonstrate basic programming techniques.
CO2: Apply concepts of functions, sequences, dictionaries
CO3: Appraise how to implement modules, files, exceptions
CO4: Create object oriented programming
CO5: Explain GUI programming, database and network programming

Unit – I **12Hrs**

Python Basics- Origin, features, Statements and Syntax, Variable Assignment, Identifiers, Basic Style Guidelines, Memory Management. 2

Python Objects- Python Objects, Type object, Null object, Object identity comparison, type () and isinstance (), Categorizing the standard types, 2

Conditionals and Loops- if, else, elif statement, Conditional Expressions, while, for statement, range() Built-in function, break, continue, pass, Iterators and iter() function, List Comprehensions, Generator Expressions 4

Numbers- Introduction, Integers, Double precision Floating point numbers, Complex numbers, Operators, Built-in and Factory functions, Other Numeric Types. 4

Unit - II **12Hrs**

Functions- Introduction, Calling functions, Creating functions, Passing functions, Formal arguments, Variable length arguments, Functional programming, variable scope, recursion, Generators 4

Sequences: Strings, Lists and Tuples- Sequences, Strings, Strings and Operators, String-Only Operators, Built-in functions, String Built-in Methods, Special features of Strings. Lists- Introduction, Operators, Built-in functions, List type Built-in methods. Tuples- Introduction, Tuple Operators and Built-in Functions, Special features of Tuples. 5

Dictionaries- Introduction, Mapping type operators, Mapping Type Built-in and Factory functions, Mapping type built-in methods, Dictionary keys. 3

Unit - III **12Hrs**

Modules- Modules, namespaces, importing modules, features of module import, built-in functions, packages. 3

Set Types- Introduction, Set type operators, Built-in functions and Methods 2

Files and Input/Output- file objects; file BIF and methods, built-in attributes, Standard files, Command line arguments, File system. 3

Exceptions- Introduction, Exceptions in python, Detecting and handling exceptions, with statement, raise statement, Assertions-assert statement, Standard Exceptions, Creating exceptions. 4

Unit-IV **12Hrs**

Object oriented programming- Buzzwords of OOPS, Classes, class attributes, Instances, Instance attributes, binding and method invocation, static methods and class methods, Sub-classing and derivation, Inheritance, Multiple inheritance, BIF for classes, instances and other objects, privacy, Wrapping, date and time functions. 4

Multithreaded programming: Introduction, Threads and processes, Thread and Python, The thread module, threading module, Synchronization primitives, Producer-Consumer Problem

GUI Programming: Tkinter and Python programming, Tkinter examples- Label, Button, Checkbutton, Entry, Canvas, Listbox, Message, Radiobutton, Scale. 5

Unit - V **12Hrs**

GUI Programming: Menu, Menubutton, Scrollbar, Spinbox, Slider, Dialogs, Text, tkMessageBox, PanedWindow, TopLevel, Frame 4

Database programming: Introduction, Database API. 3

Network programming: Introduction, Sockets-Communication Endpoints, Network Programming in python, Socket Server Module. 5

ESSENTIAL READING

1. Chun Wesley, J. **Core Python Programming**.2nd Edition. Pearson Education (Unit I, II, III, IV-Object Oriented Programming)
2. Chun Wesley, J. **Core Python Applications Programming**. 3rd Edition. Pearson Education (Unit IV, V)

DESIGN OF EXPERIMENTS, VITAL STATISTICS, OFFICIAL STATISTICS AND BUSINESS FORECASTING PRACTICAL
(Core Course-17)

Credits : 1 **Semester: VI**

Subject Code : MS21605 **No. of Practical hours: 30**

Objective: The significances of effects of various factors on a given response are determined under uncertainty using statistical principles.

Otcome: Ability to design an experiment, analyze data, interpret and present the results.

LIST OF PRACTICALS

Design of Experiments:

11. ANOVA-one-way classification with equal number of observations.
12. ANOVA-one-way classification with equal number of observations using Office Automation.
13. ANOVA-Two-way classification with equal number of observations.
14. ANOVA-Two-way classification with equal number of observations using Office Automation.
15. Analysis of CRD. Analysis of RBD with and without missing observation.
16. Analysis of CRD. Analysis of RBD with and without missing observation using Office Automation.
17. Analysis of LSD with and without missing observation.
18. Analysis of LSD with and without missing observation using Office Automation.
19. Comparison of relative efficiency of RBD with CRD and Comparison of relative efficiencies of LSD with RBD & CRD.

Vital Statistics

20. Computation of various Mortality rates, Fertility rates and Reproduction rates.
21. Construction of Life tables and Abridged Life tables.
22. Construction of various rates, Life tables and Abridged Life tables using Office Automation.

PYTHON PROGRAMMING PRACTICAL
(Core Course - 18)

Credits : 1 **Semester: VI**

Subject Code : BS21606 **No. of practical Hours: 30**

Objective: To develop applications using object oriented concepts of Python.
Outcome: Students will be able to demonstrate object oriented concepts using Python.

1	Programs on control flow in python
2-3	Programs on number, string, list, tuples and dictionary
4	Programs on files in python
5	Programs on functions and functional programming in python
6	Programs on modules, set types in Python
7	Programs on exceptions in Python
8	Programs demonstrating class and object.
9-10	Programs on inheritance and overriding in Python
11	Programs on GUI programming in Python
12	Programs on advanced controls in Python
13	Programs on data base programming in Python
14	Programs on multithreaded programming
15	Programs on network programming