Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework and Syllabus

For

M.Sc. (Mathematics)

(Based on NEP 2020 framework)

(To be implemented from the Academic Year 2023-24)

Semester 1 (First Year) Level 6

Course Type	Course Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4 + 4 + 2)	**23ScMatP111**	Major Paper 1(Theory)	Linear Algebra	4	4	50	50	100
	23ScMatP112	Major Paper 2(Theory)	Group Theory	4	4	50	50	100
	23ScMatP113	Major Paper 3(Theory)	Graph Theory	4	4	50	50	100
	23ScMatP114	Major Paper 4(Practical)	Lab Course on 23ScMatP111, 23ScMatP112 & 23ScMatP113	4	2	25	25	50
Major Electives (4)	**23ScMatP121**	Major Elective 1 (Theory + Practical)	Ordinary Differential Equations (T + P)	2 4	4	50	50	100
	23ScMatP122	Major Elective 2 (Theory + Practical)	C- Programming Language (T + P)	2 4				
RM (4)	**23ScMatP131**	RM Paper 1(Theory)	RM Paper : Core	2	4	50	50	100
		RM Paper 2 (Practical)	RM Paper : Discrete Mathematics	4				
OJT/FP								
RP								
Total				34	22			550

Semester 2 (First Year) Level 6

Course Type	Course Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4 + 4 + 2)	23ScMatP211	Major Paper 1(Theory)	Partial Differential Equations	4	4	50	50	100
	23ScMatP212	Major Paper 2(Theory)	Rings and Modules	4	4	50	50	100
	23ScMatP213	Major Paper 3(Theory)	General Topology	4	4	50	50	100
	23ScMatP214	Major Paper 4(Practical)	Lab Course on 23ScMatP211, 23ScMatP212 & 23ScMatP213	4	2	25	25	50
Major Electives (4)	23ScMatP221	Major Elective 1 (Theory + Practical)	Numerical Analysis (T + P)	2 4	4	50	50	100
	23ScMatP222	Major Elective 2 (Theory + Practical)	C++ and Data Structures (T + P)	2 4				
RM								
OJT/FP (4)	**23ScMatP241**		On Job Training	8	4			
RP								
Total				36	22			

Semester 3 (Second Year) Level 6.5

Course Type	Course Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4 + 4 + 2)	**23ScMatP311**	Major Paper 1(Theory)	Measure and Integration	4	4	50	50	100
	23ScMatP312	Major Paper 2(Theory)	Field Theory	4	4	50	50	100
	23ScMatP313	Major Paper 3(Theory)	Functional Analysis	4	4	50	50	100
	23ScMatP314	Major Paper 4(Practical)	Lab Course on 23ScMatP311, 23ScMatP312 & 23ScMatP313	4	2	25	25	50
Major Electives (4)	**23ScMatP321**	Major Elective 1 (Theory + Practical)	Mathematical Statistics and Probability (T + P)	2 4	4	50	50	100
	23ScMatP322	Major Elective 2 (Theory + Practical)	Python Programming Language (T + P)	2 4				
RM								
OJT/FP								
RP (4)	**23ScMatP351**		Research Project- I	8	4			
Total				36	22			

Semester 4 (Second Year) Level 6.5

Course Type	Course Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4 + 4)	**23ScMatP411**	Major Paper 1(Theory)	Complex Analysis	4	4	50	50	100
	23ScMatP412	Major Paper 2(Theory)	Applied Combinatorics	4	4	50	50	100
	23ScMatP413	Major Paper 3(Theory)	Number Theory	4	4	50	50	100
Major Electives (4)	**23ScMatP421**	Major Elective 1 (Theory +Practical)	Computational Geometry (T + P)	2 4	4	50	50	100
	23ScMatP422	Major Elective 2 (Theory +Practical)	Data Mining with R Package (T + P)	2 4				
RM								
OJT/FP								
RP (6)	**23ScMatP451**		Research Project-II	12	6			
Total				36	22			

OE : Open Elective
AEC: Ability Enhancement Course
VEC: value Education Courses
CC : Co-Curricular Courses
IKS : Indian Knowledge System
OJT : On Job Training
FP : Field Project
VSC : Vocational Skill Courses
CEP : Community Engagement Project

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PG Part 2 Year of M.Sc. (Mathematics) (Semester-III)
(2023 Course under NEP 2020)

Course Code : 23ScMatP311

Course Name : Measure and Integration

Teaching Scheme: TH: 4 Hours/Week **Credit: 4**

Examination Scheme: CIE: 50 Marks **End-Sem: 50 Marks**

Prerequisite Course: Real analysis

Course Objectives:- To Study:

- Measure theory on a set such as Cantor set
- Theory of Lebesgue integration
- Egorov's theorem to establish a condition for the uniform convergence of a pointwise convergent sequence of measurable functions.
- Riemann integrable functions
- Differentiation of functions on Euclidean space.

Course Outcomes:

On completion of the course, student will be able to–

- Find exterior measure and Lebesgue measure
- Check measurability of sets
- Find differentiation and integration of functions on Euclidean space.
- Apply Fubini's theorem to evaluate Gaussian integral.
- Apply Fatou's lemma to determine existence of Lebesgue integrals

Course Contents:

Unit 1	Measure Theory	24 lectures
	• Exterior measure • Measurable sets • Cantor Set • Lebesgue measure • Invariance properties of Lebesgue measure • σ- algebras and Borel sets. • Construction of a non-measurable set • Measurable functions	

	• Littlewood's three principles • Egorov's theorem	
Unit 2	Lebesgue Integration	20 lectures
	• The Lebesgue Integral • Basic properties of Lebesgue integral • Bounded convergence theorem • Riemann integrable functions • Fatou's lemma • Monotone convergence theorem • The space L^1 of integrable functions • Riez-Fischer theorem • Invariance properties of function • Fubini's theorem. • Applications of Fubini's theorem.	
Unit 3	Differentiation and Integration	16 lectures
	• Differentiation of the integral • Hardy-Littlewood maximal function. • Lebesgue differentiation theorem • Good kernels and approximation to the identity • Differentiability of functions • Functions of bounded variation • Dini numbers • Cantor-Lebesgue function • Differentiability of jump functions.	
	TOTAL	60 lectures

Reference Books:

1. Real Analysis by E. Stein and R. Shakharchi, Princeton University Press, 2005.
2. Measure and integration theory by G.de Barra, Woodhead Publishing Ltd., 2003.
3. Real Analysis by H. Royden, Prentice hall (Fourth edition), 2010.
4. Principles of Mathematical Analysis by W. Rudin, Prentice Hall (Third Edition), 1976.

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 Course under NEP 2020)

Course Code : 23ScMatP312

Course Name : Field Theory

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIE: 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses: Theory of groups, Theory of rings.

Course Objectives: To study

- The concept of field, extension of field, splitting field
- Cyclotomic polynomial, Galois theory, Solvable and radical extensions
- Seperable and inseperable extensions and infinite Galois groups
- Solvability of polynomials

Course Outcomes: On completion of the course, student will be able to know

- The concept of field theory, extension of field, splitting field
- Cyclotomic polynomial, Galois theory, Solvable and radical extensions
- Seperable and inseperable extensions
- Solvability of polynomials

Course Contents:

Unit 1	Field	12 Lectures
	• Basic theory of field extensions • Algebraic Extensions and its properties • Classical straightedge and compass constructions	
Unit 2	Splitting field	14 Lectures
	• Splitting field and algebraic closure • Separable and Inseparable extensions • Cyclotomic polynomials and extensions	
Unit 3	Galois Theory	20 Lectures
	• Basic definitions and its properties • Fundamental theorem of Galois	

	theory ● Composite extensions ● Simple extensions ● Cyclotomic extensions over Q ● Abelian extensions over Q ● Galois groups of polynomials	
Unit 4	Solvability and insolvability of polynomial	14 lectures
	● Solvable and radical extensions ● Insolvability of the Quintic polynomials	
	Total :	60 Lectures

Reference Books:

1. Abstarct algebra by Dammit and Foote, Wiley publication, (Third edition), 2011
2. Basic Abstract Algebra by P.B.Bhattacharya, Combridge University Press, (Second edition), 1994
3. Contemporary abstract algebra by Joseph Gallian, Narosa Publishing House, (Seventh edition), 1999
4. Fields and Galois Theory by John M. Howie, Springers, (First edition), 2007

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PG Part 2 Year of M.Sc. (Mathematics) (Semester-III)
(2023 Course under NEP 2020)

Course Code: 23ScMatP313

Course Name: Functional Analysis

Teaching Scheme: TH: 4 Hours/Week **Credit: 4**

Examination Scheme: CIE: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses: Metric spaces, Linear Algebra, Measure Theory, Topology.

Course Objectives: To Study

- Hilbert spaces and Operators on Hilbert spaces.
- Orthogonality of vectors
- Diagonalization of compact self operators
- Banach spaces
- Linear Functions

Course Outcomes: On completion of the course, student will be able to

- Design and solve examples of Hilbert spaces.
- Find orthonormal set of vectors and bases.
- Design and solve examples of Banach spaces.
- Find Quotient and product of normed spaces
- Show the existence of continuous linear extensions of continuous linar functionals using Hahn-Banach theorem.
- Find the dual of quotient space and subspace.

Course Contents:

Unit 1	Hilbert Spaces	15 lectures
	• Elementary properties and examples • Orthogonality • The Riesz representation theorem • Orthonomal set of vectors and bases • Isomorphic Hilbert spaces and the fourier transform for the circle • The direct sum of Hilbert spaces	

Unit 2	Operators on Hilbert Spaces	25 lectures
	• Elementary properties and examples • The adjoint of an operator • Projections and idempotents invariant and reducing subspaces • Compact operators • The Diagonalization of compact self-adjoint operators • An application: Strum-Liouville system • The spectral theorem and functional calculus for compact normal operators	
Unit 3	Banach Spaces	20 lectures
	• Elementary properties and examples • Linear operator on normed spaces • Finite dimensional normed spaces • Quotient and product of normed spaces • Linear functions • The Hahn-Banach theorem • An application: Runge's theorem • An application: Ordered vector spaces • The dual of quotient space and subspace • The open mapping and closed graph theorems	
	TOTAL	60 lectures

Reference Books:

- Functional analysis by Balmohan Limaye, New Age International (P) Limited (Second edition), 1996.
  Book link: https://archive.org/details/functionalanalys00lima/page/n7/mode/2up
- A course in functional analysis by John B. Conway, Springer, 1997.
  Book link: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwiemrSa1cTpAhW-yDgGHf0HB8MQFjABegQIARAB&url=http%3A%2F%2Fentsphere.com%2Fpub%2Fpdf%2FA%2520Course%2520in%2520Functional%2520Analysis%2520-%2520Conway.pdf&usg=AOvVaw1Br5CRKC-uV1bnpdKjmD-G
- Beginning functional analysis by Karen Saxe, Springer New York, 2013.
- Linear analysis by Bela Bollabas, Cambridge university Press (Second edition), 2018.

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 course under NEP 2020)

Course Code: 23ScMatP314

Course Name: Lab Course on 23ScMatP311, 23ScMatP312 & 23ScMatP313

Teaching Scheme: TH: 4 Hours/Week **Credits: 2**

Examination Scheme: CIE: 25 Marks **End-Sem: 25 Marks**

Prerequisite Courses : Measure Theory, Field Theory, Functional Analysis

Course Objectives: The aim of this course is to study

- Measure theory on the set, Cantor Set, Lebesgue Differentiation and Integration
- Algebraic Extensions, Splitting field, Cyclotomic field and Extension
- Galois extensions and Solvability of polynomials
- Hilbert Spaces, Banach Spaces, Applications of Banch Spaces

Course Outcomes : On completion of the course, student will be able to solve

- The problems on Measure theory on the set, Cantor Set, Lebesgue Differentiation and Integration
- The problems on Algebraic Extensions, Splitting field, Cyclotomic field and Extension
- The problems Galois extensions and Solvability of polynomials
- The problems Hilbert Spaces, Banach Spaces, Applications of Banch Spaces

Course Contents:

Practical 1 : Exterior Measure

Practical 2: Measurable functions

Practical 3 : Lebesgue Integration

Practical 4 : Lebesgue Differentiation

Practical 5: Functions of Bounded Variations

Practical 6 : Algebraic Extensions

Practical 7 : Splitting field

Practical 8 : Cyclotomic Extensions

Practical 9 : Galois Extensions

Practical 10 : Solvability of Polynomials

Practical 11 : Hilbert Spaces

Practical 12 : Orthogonality of Hilbert Spaces

Practical 13 : Operators on Hilbert Spaces

Practical 14 : Banach Spaces

Practical 15: Application of Banach Spaces

Reference Books:

1. Real Analysis by Elias M. Stein & Rami Shakarchi, Princeton University Press, 2005.
2. Abstarct algebra by Dammit and Foote, Wiley publication, (Third edition), 2011.
3. A course in functional analysis, John B. Convey, Springer, 1997.

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 course under NEP 2020)

Course Code: 23ScMatP321

Course Name: Mathematical Statistics and Probability

Teaching Scheme: TH: 2 Hours/Week **Credits: 2**

Examination Scheme: CIE: 25 Marks **End-Sem: 25 Marks**

Prerequisites: Sets, Permutations and Combinations.

Course Objectives:

- To provide the foundation and exposure to statistical ideas.
- To study discrete and continuous probability distributions.
- To develop the knowledge of probability and the logic of hypothesis testing.

Course Outcomes: On completion of the course, student will be able to–

- Understand the elementary probability theory and concepts of statistical distributions.
- Understand the basic concepts of statistical inference.

Course Contents:

Unit 1	Introduction to Probability	3 Lectures
	• Sample space and events • Probability of an event • Properties of probabilities • Concept of Conditional Probability • Bayes' Rule	
Unit 2	Random Variables and Distributions	7 Lectures
	• Definition and types of random variables • Discrete probability distribution • Continuous probability distribution • Joint probability distribution • Independent random variables • Expected value and Variance for discrete and continuous random variables • Moment Generating function	
Unit 3	Discrete Probability Distributions	8 Lectures
	• Discrete uniform distribution	

	• Bernoulli and Binomial distribution • Geometric Distribution • Negative binomial distribution • Hypergeometric distribution • Poisson distribution	
Unit 4	Continuous Probability Distribution	8 Lectures
	• Continuous uniform distribution • Normal Distribution • Area under the normal curve • Applications of the normal distribution • Normal approximation to binomial distribution • Gamma and exponential distribution • Chi-squared distribution	
Unit 5	Statistical Hypothesis	4 Lectures
	• Sample, population and statistical inference • General Concepts: Null and alternative hypothesis, type I and type II errors , test statistic, critical region , level of significance, probability value (p-value) • One sample test for estimation of mean (variance known) and confidence interval • One sample test for estimation of mean (variance unknown) and confidence interval	
	TOTAL :	30 Lectures

Reference Books:

1. A first course in probability by S. Ross, Pearson Publication, 9th edition, 2016. https://drive.google.com/file/d/1uCd18g97d1_VFf9gWxYt68N_4UlBHSPi/view?usp=sharing
2. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand and Sons, 3rd edition, New Delhi, 1987.
3. Probability and Statistics for engineers and scientists by R. Walpole, R. H. Myers and K. Ye, Pearson Publication, 7th edition, 2011.
4. Discrete Probability and Probability Distributions by Dr. P. G. Dixit, Prof P. S. Karpe, Nirali Publication, 2013

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 Course under NEP 2020)

Course Code: 23ScMatP321

Course Name: Practicals on Mathematical Statistics and Probability

Teaching Scheme: TH: 4 Hours/Week **Credit: 2**

Examination Scheme: CIE: 25 Marks **End-Sem: 25 Marks**

Prerequisites: Sets, Permutations and Combinations.

Course Objectives:

- To provide the foundation and exposure to statistical ideas.
- To study discrete and continuous probability distributions.
- To develop the knowledge of probability and the logic of hypothesis testing.

Course Outcomes: On completion of the course, student will be able to–

- Understand the elementary probability theory and concepts of statistical distributions.
- Understand the basic concepts of statistical inference.

Course Contents:

Practical 1: Probability

Practical 2: Random Variables

Practical 3: Mean and Variance
Practical 4: Binomial Distribution

Practical 5: Poisson's Distribution
Practical 6: Hypergeometric Distribution
Practical 7: Geometric Distribution

Practical 8: Negative Binomial Distribution
Practical 9: Moment generating function
Practical 10: Continuous Probability Distribution

Practical 11: Normal Distribution

Practical 12: Exponential Distribution

Practical 13: Gamma Distribution
Practical 14: Chi-Square Distribution
Practical 15: Hypothesis Testing

Reference Books:

5. A first course in probability by S. Ross, Pearson Publication, 9th edition, 2016. https://drive.google.com/file/d/1uCd18g97d1_VFf9gWxYt68N_4UlBHSPi/view?usp=sharing
6. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand and Sons, 3rd edition, New Delhi, 1987.
7. Probability and Statistics for engineers and scientist by R. Walpole, R. H. Myers and K. Ye, Pearson Publication, 7th edition, 2011.
8. Discrete Probability and Probability Distributions by Dr. P. G. Dixit, Prof P. S. Karpe, Nirali Publication, 2013.

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 course under NEP 2020)

Course Code: 23ScMatP322

Course Name: Python Programming

Teaching Scheme: TH: 2 Hours/Week **Credits: 2**

Examination Scheme: CIE: 25 Marks **End-Sem: 25 Marks**

Prerequisites:
- Basic computer skills
- Front End Vs Back End
- Probability and Statistics

Course objectives: The students will learn
- To introduce programming concepts using python
- To develop Programming logic using python
- To develop basic concepts and terminology of python programming
- To test and execute python programs

Course Outcomes: On completion of the course, student will be able to–
- Develop logic for problem solving
- Determine the methods to create and develop **Python programs** by utilizing the data
- Structures like lists, dictionaries, tuples and sets.
- To be familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.
- To write python programs and develop a small application project.

Course Contents:

Unit 1	An Introduction to Python	6 Lectures
	• The Python Programming Language, History, features, Applications, Installing Python, Running Simple Python program • Basics of Python	

	• Standard data types - basic, none, Boolean (true & False), numbers, Variables, Constants, Python identifiers and reserved words, Lines and indentation, multi-line statements and Comments, Input/output with print and input, functions Declaration, Operations on Data such as assignment, arithmetic, relational, logical and bitwise operations, dry run, Simple Input and output etc.	
Unit 2	Control Statements	8 Lectures
	• Precedence of operators, Type conversion • if, if-else, nested if-else, • for, while, nested loops, loop control statements (break, continue, pass) • Declaration, manipulation, special operations, escape character, string formatting operator, Raw String, Unicode • Strings, Built-in String methods.	
Unit 3	Lists, functions, tuples and dictionaries, Sets	8 Lectures
	• Concept, creating and accessing elements, updating & deleting lists, traversing a List, reverse Built-in List Operators, Concatenation, Repetition, In Operator, Built-in List functions and methods. • Function Calls, Type Conversion Functions, Math Functions, Composition, Adding New Functions, Flow of Execution, Parameters and Arguments, Variables and Parameters, Stack Diagrams, Void Functions, Anonymous functions Importing with from, Return Values, Boolean Functions, More Recursion, Functional programming tools - filter(), map(), and reduce(),recursion, lambda forms. • Tuples, Accessing values in Tuples, Tuple Assignment, Tuples as return values, Variable-length argument tuples, and Basic tuples operations, Concatenation, Repetition, in Operator, Iteration, Built-in tuple functions, indexing, slicing and	

	matrices. Creating a Dictionary, Accessing Values in a dictionary, Updating Dictionary, Deleting Elements from Dictionary, Properties of Dictionary keys, Operations in Dictionary, Built-In Dictionary Functions, Built-in Dictionary Methods. ● Definition, transaction of set(Adding, Union, intersection), working with sets	
Unit 4	Modules, Working with files, Exception handling	8 Lectures
	● Importing module, Creating & exploring modules, Math module, Random module, Time module ● Importing package, creating package, examples ● Creating files and Operations on files (open, close, read, write), File object attributes, file positions, Listing Files in a Directory, Testing File Types, Removing files and directories, copying and renaming files, splitting pathnames, creating and moving directories ● Concept of regular expression, various types of regular expressions, using match function. ● Built-in Exceptions, Handling Exceptions, Exception with Arguments, User-defined Exceptions.	
	TOTAL :	30 Lectures

Reference Books:

1. An Introduction to Computer Science using Python 3 by Jason Montojo, Jennifer Campbell, Paul Gries, The pragmatic bookshelf-2013
2. James Payne, "Beginning Python: Using Python and Python 3.1,Wrox Publication
3. Introduction to Computer Science Using Python- Charles Dierbach, Wiley Publication Learning with Python ", Green Tea Press, 2002
4. Introduction to Problem Solving with Python by E balguruswamy,TMH publication- 2016
5. Beginning Programming with Python for Dummies Paperback – 2015 by John Paul Mueller
6. Object-oriented Programming in Python, Michael H. Goldwasser, David Letscher, Pearson Prentice Hall-2008
7. https://docs.python.org/3/tutorial/index.html
8. https://www.rgmcet.edu.in/assets/img/departments/CSE/materials/R19/2-1/Python%20Lab.pdf

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PG Part 2 Year of M.Sc. Mathematics (Semester-III)
(2023 Course under NEP 2020)

Course Code: 23ScMatP322

Course Name: Practicals on Python Programming

Teaching Scheme: TH: 4 Hours/Week Credits: 2

Examination Scheme: CIE: 25 Marks End-Sem: 25 Marks

Prerequisites:

- Basic computer skills
- Front End Vs Back End
- Probability and Statistics

Course objectives: The students will learn

- To introduce programming concepts using python
- To develop Programming logic using python
- To develop basic concepts and terminology of python programming
- To test and execute python programs

Course Outcomes: On completion of the course, student will be able to–

- Develop logic for problem solving
- Determine the methods to create and develop **Python programs** by utilizing the data
- Structures like lists, dictionaries, tuples and sets.
- To be familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.
- To write python programs and develop a small application project.

Course Contents:

Practical 1: Introduction to Python

Practical 2: Sequence Control

Practical 3: Conditional Statements
Practical 4: Looping
Practical 5: Strings

Practical 6: Python Lists
Practical 7: Arrays
Practical 8: Functions
Practical 9: Sets
Practical 10: Tuples and Dictionaries

Practical 11: Modules
Practical 12: Package
Practical 13: Working with files
Practical 14: Regular Expression
Practical 15: Exception Handling and Date-Time

Reference Books:

1. An Introduction to Computer Science using Python 3 by Jason Montojo, Jennifer Campbell, Paul Gries, The pragmatic bookshelf-2013
2. James Payne, "Beginning Python: Using Python and Python 3.1,Wrox Publication
3. Introduction to Computer Science Using Python- Charles Dierbach, Wiley Publication Learning with Python ", Green Tea Press, 2002
4. Introduction to Problem Solving with Python by E balguruswamy,TMH publication- 2016
5. Beginning Programming with Python for Dummies Paperback – 2015 by John Paul Mueller
6. Object-oriented Programming in Python, Michael H. Goldwasser, David Letscher, Pearson Prentice Hall-2008
7. https://docs.python.org/3/tutorial/index.html
8. https://www.rgmcet.edu.in/assets/img/departments/CSE/materials/R19/2-1/Python%20Lab.pdf

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PG Part 2 Year of M.Sc. (Mathematics) (Semester-IV)
(2023 Course under NEP 2020)

Course Code: 23ScMatP411

Course Name: Complex Analysis

Teaching Scheme: TH: 4 Hours/Week **Credit: 4**

Examination Scheme: CIE: 50 Marks **End-Sem: 50 Marks**

Prerequisites: Complex numbers, Sets and functions.

Course Objectives: To Study:-

- Holomorphic functions
- Integration along curves
- Cauchy's theorem
- Meromorphic functions.
- Zeros and poles
- Singularities
- Bilinear Transformation.

Course Outcomes: On completion of the course, student will be able to–

- Find integration along curves.
- Find Integral value of Meromorphic functions.
- Find Radius of Convergence, poles, residues.
- Find Mapping between two Complex functions.

Course Contents:

Unit 1	Priliminaries to Complex numbers	16 lectures
	• Complex Number and the Complex plane • Basic Properties • Convergence • Sets in the complex plane • Functions on the Complex plane • Continuous functions • Holomorphic functions • Power series • Integration along Curves	
Unit 2	Cauchy's Theorem and It's Applications	18 lectures

	• Goursat's theorem • Local existence of primitives and Cauchy's theorem in a disk • Evaluation of some integrals • Further applications • Morera's theorem • Sequences of holomorphic functions • Holomorphic functions defined in terms of integral • Schwartz reflection principle • Runge's approximation theorem.	
Unit 3	Moromorphic Functions and the Logarithm	18 lectures
	• Zeros and Poles • The residue formula and it's examples • Singularities and meromorphic function • The argument principle and applications • Homotopies and simply connected domain • The complex logarithm • Fourier series and harmonic functions	
Unit 4	Bilinear Transformation and Mappings	8 lectures
	• Basic mappings • The disc and upper half plane • Automorphism of disc • Automorphism of upper half plane • Linear fractional transformations	
	TOTAL	60 lectures

Reference Books:

1. Complex Analysis by E. Stein and R Shakarchi, Princeton university press, 2003.
2. Foundations of Complex Analysis by S. Ponnusamy, Birkhauser Boston, 2006.
3. Functions of one complex variable by John. B. Conway, Springer-Verlag New York (second edition), 1978.
4. Complex Analysis by Ian Stewart, David Tall, Cambridge University Press (Second edition), 2018.

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PG Part 2 Year of M.Sc. (Mathematics) (Semester-IV)
(2023 Course under NEP 2020)

Course Code: 23ScMatP412

Course Name: Applied Combinatorics

Teaching Scheme: TH: 4 Hours/Week **Credit: 4**

Examination Scheme: CIE: 50 Marks **End-Sem: 50 Marks**

Prerequisites: Permutation and combination, Polynomials, functions

Course Objectives: To study-

- Arrangements and selection.
- Generating functions.
- Recurrence relations.
- Inclusion-exclusion formula and rook polynomials.
- Polya's theory.

Course Outcomes: On completion of the course, student will be able to

- Find number of different ways of arrangements and selections.
- Find generating functions.
- Find solutions of homogeneous and nonhomogeneous recurrence relations.
- Use inclusion-exclusion formula and find rook polynomials.

Course Contents:

Unit 1	General counting methods for arrangements and selections	8 lectures
	• Addition and multiplication principles • Simple arrangements and selections • Arrangements and selections with repetitions • Distributions	
Unit 2	Generating functions	12 lectures
	• Generating function models • Calculating coefficients of generating functions • Partitions • Exponential generating functions	

	• A summation method	
Unit 3	Recurrence relations	15 lectures
	• Recurrence relation models • Divide and conquer relations • Solution of linear recurrence relations • Solution of inhomogeneous recurrence relations • Solutions with generating functions	
Unit 4	Inclusion-Exclusion	10 lectures
	• Inclusion-Exclusion formula • Restricted positions and rook polynomials	
Unit 5	Polya's enumeration formula	15 lectures
	• Equivalence and symmetry groups. • Burnside's theorem • Polya's formula	
	TOTAL:	60 Lectures

Reference Books:

1. Applied Combinatorics by Alan Tucker, John Wiley and sons (Sixth edition), 2012.
2. Combinatorial, Theory and Applications by V. Krishnamurthy, East West press, New Delhi, 1996.
3. Discrete Mathematics and its Applications with Combinatorics and Graph Theory by Kenneth H. Rosen, Tata McGraw-Hill Publishing Company Limited (Sixth edition), 2008.

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PG Part 2 Year of M.Sc. Mathematics (Semester-IV)
(2023 Course under NEP 2020)

Course Code : 23ScMatP413

Course Name : Number Theory

Teaching Scheme: TH:4 Hour/Week **Credit: 4**

Examination Scheme: CIE : 50 Marks **End-Sem : 50 Marks**

Prerequisites:

- The properties of Integers
- System of equations
- Algebra of polynomials

Course Objectives: To Study

- The divisibility of integers and its properties
- Solution of congruences
- Quadratic reciprocity
- Properties of some functions of number theory
- Algebraic number field

Course Outcomes: On completion of the course, student will be able to know:

- The divisibility of integers and its properties
- Solution of congruences
- Quadratic reciprocity
- Properties of some functions of number theory
- Algebraic Numbers and properties

Course Contents:

Unit 1	Divisibility	6 Lectures
	• Introduction • Divisibility • Primes	
Unit 2	Congruence	12 Lectures
	• Congruence • Solutions of Congruence • The Chinese Remainder theorem	
Unit 3	Quadratic reciprocity and quadratic	12 Lectures

	forms	
	• Quadratic Residues • Quadratic Reciprocity • The Jacobi Symbol	
Unit 4	Some functions of number theory	12 Lectures
	• Greatest Integer function • Arithmetic functions • The Mobius Inversion formula • Some Diophantine equation • Pythagorean triples	
Unit 5	Algebraic numbers	18 Lectures
	• Polynomials • Algebraic numbers • Algebraic number fields • Algebraic Integers • Quadratic fields • Units in quadratic fields • Primes in quadratic fields • Unique factorization • Primes in quadratic fields having uniques factorization property	
	Total :	60 Lectures

Reference Books:

1. Introduction to the theory of numbers by Ivan Niven and Herbert S. Zukerman, Wiley publication, (Fifth edition), 1991
2. Elementary Number Theory by David Burton, McGraw Hill education, (Seventh edition), 2017
3. Elementary Number Theory by William Stein, CreateSpace independent Publishing Platform, 2014

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PG Part 2 Year of M.Sc. Mathematics (Semester-IV)
(2023 Course under NEP 2020)

Course Code: 23ScMatP421

Course Name: Computational Geometry

Teaching Scheme: TH: 2 Hours/Week **Credit: 2**

Examination Scheme: CIE : 25 Marks **End-Sem : 25 Marks**

Prerequisite Courses: Algebra of Matrices, Geometry.

Course Objectives: To Study

- Representation of two and three dimensional objects
- Transformation of two and three dimensional objects
- Representation of plane curves and space curves
- Generation of points on circle, ellipse, etc.
- Bezier curves

Course Outcomes: On completion of the course, student will be able to know

- Representation of two and three dimensional objects
- Transformation of two and three dimensional objects
- Representation of plane curves and space curves
- How to generate points on circle, ellipse, etc.
- Bezier curves

Course Contents :

Unit 1	Two dimensional transformations	12 Lectures
	• Representation of points • Transformations and matrices • Transformation of points, straight, parallel and intersecting lines • Rotation, reflection, scaling • Transformation of unit square, solid body transformation. • Rotation about arbitrary point, reflection through arbitrary line • Geometric interpretation of Homogeneous coordinate, overall scaling, points at infinity, transformation conventions	

Unit 2	Three dimensional transformations	12 Lectures
	• Three dimensional scaling, shearing, rotation, reflection, translation, multiple transformations • Rotation about an axis parallel to coordinate axis, about an arbitrary axis • Affine and perspective geometry, orthographic, axonometric and oblique projections • Techniques for generating perspective view, vanishing points, photography and perspective transformation • Stereographic projection, comparison of object fixed and center of projection • Fixed projections, reconstruction of three dimensional images	
Unit 3	Plane curves	6 Lectures
	• Curve representation • Parametric and non-parametric curves • Parametric representation of circle, ellipse, parabola, hyperbola • Introduction,definition and properties of Bezier curves	
	TOTAL	30 Lectures

Reference Book:

1. Mathematical elements of computer graphics by D.F. Rogers and J. Alan Admas, McGraw Hill publication, (Second Edition), 2017
2. Applied Geometry for Computer Graphics and CAD by Duncan Marsh, Spinger, (Second Edition), 2005
3. Geometric Tools for Computer graphics by Philip J. Schneider and David H. Eberly, Morgan Kaufmann, (First edition), 2002
4. Computational Geometry by Joseph O Rourke, Combridge University Press, (Second Edition), 1998
5. Field Theory by Serge Lang, Springer-Verlag New York Inc, 1987

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PG Part 2 Year of M.Sc. Mathematics (Semester-IV)
(2023 course under NEP 2020)

Course Code: 23ScMatP421

Course Name: Practicals on Computational Geometry

Teaching Scheme: TH: 4 Hours/Week **Credits : 2**

Examination Scheme: CIE: 25 Marks **End-Semester: 25 Marks**

Prerequisite Courses : Matrix Algebra, Analytical Geometry and Scilab

Course Objectives: The aim of this course is to study

- The use of matrices in representation of objects and transformations.
- The affine transformations of two and three dimensional objects.
- The concept of projections and its various types.
- Matrix operations using Scilab

Course Outcomes : On completion of the course, student will be able to understand

- The applications of matrices in affine transformations of two and three dimensional objects.
- The applications of computational geometry in the field of architecture, animation, designing and civil engineering.
- The polynomial approximation of given discrete data.
- The matrix operations and transformations using Scilab

Course Contents:

Practical 1 : Two dimensional transformations

Practical 2: Transformation of lines

Practical 3 : Combined transformations

Practical 4 : Homogeneous coordinates

Practical 5: Rotation about arbitrary point

Practical 6 : Reflection through arbitrary line

Practical 7 : Three dimensional transformations

Practical 8 : Rotations about standard axes

Practical 9 : Reflections through standard planes

Practical 10 : Arbitrary rotations and reflections

Practical 11 : Orthographic and Axonometric projections

Practical 12 : Oblique and perspective projections

Practical 13 : Generation of points on circle and ellipse

Practical 14 : Generation of points on parabola and hyperbola

Practical 15: Bazier Curve

Reference Books:

1. Mathematical elements for Computer graphics by D. F. Rogers, J. A. Adams, Tata Mc Graw Hill International Edition, Second edition, 2002.
2. Computer Graphics with Open GL by Donald Hearn and M. Pauline Baker, Warren Carithers, Pearson (4th Edition), 2014.
3. Computer Graphics by Schaum's Outline Series, Tata Mc Graw Hill International Edition, 2015.

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PG Part 2 Year of M.Sc. Mathematics (Semester-IV)
(2023 course under NEP 2020)

Course Code: 23ScMatP422

Course Name: Data Mining with R

Teaching Scheme: TH: 2 Hours/Week Credits: 2

Examination Scheme: CIE: 25 Marks End-Sem: 25 Marks

Prerequisites:

- Knowledge of basic probability concepts and standard probability distributions.
- Basic concepts of non-linear programming.
- Regression Analysis

Course objectives: The students will learn

- To get knowledge by self-study, observation, experience and/or by being taught.
- Data mining deals with the design, analysis and validation of algorithms that enable computers (machines) to learn from data and automatically extract methods to perform intended tasks.
- The main objective of this course is to introduce some standard learning algorithms for tasks such as classification, regression, clustering, outlier detection and association finding.

Course Outcomes: On completion of the course, student will be able to–

- Student will increase its own potential for improved performance and learning in future.
- Apply various ML. algorithms for data analysis, particularly when data is large.
- Apply various ML. algorithms for model free statistics Inference. Which can be studied by any one from any discipline.

Course Contents:

Unit 1	Introduction to Data Mining	8 Lectures
	• Data preparation for knowledge discovery: Data understanding and data cleaning tools, Data transformation, Data Discretization, Data Visualization • Data Mining Process: CRISP and SEEMA, Supervised and unsupervised learning techniques.	

Unit 2	Classification	8 Lectures
	• Problem of classification • Classification techniques: k-nearest neighbour, decision tree, Naïve Bayesian, classification based on logistics regression.	
Unit 3	Model Evaluation, Selection and Classification Accuracy	14 Lectures
	• Model evaluation and selection: Metrics for Evaluating Classifier Performance. • Concept of training data, testing data and validation of model, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance • Techniques to Improve Classification • Accuracy: Introduction to Ensemble Methods, Bagging • Boosting and Ada Boost, Improving Classification Accuracy of Class Imbalanced Data	
	TOTAL :	30 Lectures

Reference Books:

1. Berson and Smith S.J. (1997): Data warehousing, Data Mining, and OLAP, McGraw-Hill
2. Breiman J.H Friedman, R.A. Olshen and stone C.J. (1984). Classification and Regression Trees, Wadsworth and Brooks /Cole
3. Han, J. and Kamber, M and Pei, J. (2012): Data Mining Concepts and Techniques. MorganGaufinann 3rd Edition.
4. Mitchell TM. (1997): Machine Learming, McGraw-Hill
5. https://rstudio.github.io/r-manuals/
6. https://cran.r-project.org/bin/windows/base/

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PG Part 2 Year of M.Sc. Mathematics (Semester-IV)
(2023 Course under NEP 2020)

Course Code: 23ScMatP422

Course Name: Data Mining with R

Teaching Scheme: TH: 4 Hours/Week **Credits: 2**

Examination Scheme: CIE: 25 Marks **End-Sem: 25 Marks**

Prerequisites:

- Basic computer skills
- Basic concepts of statistics
- Regression Analysis

Course objectives: The students will learn

- To get knowledge by self-study, observation, experience and/or by being taught.
- Data mining deals with the design, analysis and validation of algorithms that enable computers (machines) to learn from data and automatically extract methods to perform intended tasks.
- The main objective of this course is to introduce some standard learning algorithms for tasks such as classification, regression, clustering, outlier detection and association finding.

Course Outcomes: On completion of the course, student will be able to–

- Student will increase its own potential for improved performance and learning in future.
- Apply various ML. algorithms for data analysis, particularly when data is large.
- Apply various ML. algorithms for model free statistics Inference. Which can be studied by any one from any discipline.

Course Contents:

Practical 1: Importing Data

Practical 2: Matrix operations

Practical 3: Graphs and Diagrams
Practical 4: Computation of Descriptive Statistics
Practical 5: Mathematical Averages

Practical 6: Positional Averages
Practical 7: Calculations of measures of central Tendency using R
Practical 8: Measure of Dispersion

Practical 9: Skewness and Kurtosis
Practical 10: Correlation, Regression analysis
Practical 11: Discrete probability distributions

Practical 12: Continuous probability distributions

Practical 13: Curve fitting

Practical 14: Testing of Hypothesis

Practical 15: Random Sampling from a probability distribution

Reference Books:

1. Berson and Smith S.J. (1997): Data warehousing, Data Mining, and OLAP, McGraw-Hill
2. Breiman J.H Friedman, R.A. Olshen and stone C.J. (1984). Classification and Regression Trees, Wadsworth and Brooks /Cole
3. Han, J. and Kamber, M and Pei, J. (2012): Data Mining Concepts and Techniques. MorganGaufinann 3rd Edition.
4. Mitchell TM. (1997): Machine Learming, McGraw-Hill
5. https://rstudio.github.io/r-manuals/
6. https://cran.r-project.org/bin/windows/base/