MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

M.Sc. MATHEMATICS (Affiliated Colleges)

LEARNING OUTCOME BASED CURRICULUM

(For those who joined from 2021-2022 onwards)

VISION AND MISSION OF THE UNIVERSITY

VISION

" To provide quality education to reach the unreached "

MISSION

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

VISION AND MISSION OF DEPARTMENT

VISION

To emerge as a department of science, which will provide strong foundations in the areas of Pure and Applied Mathematics in order to develop innovative minds for interdisciplinary research. Excellence in research and leaders as educators in the region.

MISSION

- To develop and implement student centric teaching learning methods.
- To produce fundamentally and conceptually strong academicians and research oriented Mathematicians who will constructively contribute to the overall growth of the society.
- To usher in construction of the thinking of students to Mathematically tackle modern problems and challenges.
- To develop strong communication skills among students.
- To develop strong moral values.
- To develop strong foundations in Mathematics to have sound analytical and critical thinking ability for innovative solutions in practical problems.
- To continuously improve the basic infrastructure in pursuit of providing the necessary environment for academic excellence.
- To develop a nurturing environment for lifelong learning.

PREAMBLE

M.Sc. Mathematics programme has a total of 90 credits spread over four semesters. The programme emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, number of elective courses, extensive computer training including standard software packages such as PYTHON etc. The independent project work is one of the important components of this program. The syllabus covers most of the core courses and elective courses with computer course PYTHON. The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics. It is possible for the students to study basic courses from other disciplines such as Computer Science and Applied Mathematics in place of electives.

PROGRAMME STRUCTURE

Semester	Class	Paper	Allotted Hours	Credits
I	I M.Sc. Mathematics	Core – 1, Algebra - I	6	4
		Core – 2, Analysis – I	6	4
		Core – 3, Analytic Number Theory	6	4
		Core – 4, Operations Research	6	4
		Core – 5, Ordinary Differential Equations	6	4
II	I M.Sc. Mathematics	Core – 6, Algebra - II	5	4
		Core – 7, Analysis – II	5	4
		Core – 8, Advanced Calculus	5	4
		Core – 9, Differential Geometry	5	4
		Core – 10,Research Methodology and Statistics	5	4
		Elective – 1 (Choose any one) :		
		1.1. Classical Mechanics		
		1.2. Partial Differential Equations	5	4
		1.3. Python Programming-Theory		
III	II M.Sc. Mathematics	Core – 11, Advanced Algebra – I	6	4
		Core – 12, Graph Theory	6	4
		Core – 13, Measure and Integration	6	4
		Core – 14, Topology - I	6	4
		Elective – 2 (Choose any one):		
		2.1. Algebraic Number Theory		
		2 .2. Calculus of Variation and Integral Equations	6	4
		2.3. Python Programming-Practicals		
IV	II M.Sc. Mathematics	Core – 15, Advanced Algebra -II	5	4
		Core – 16, Complex Analysis	5	4
		Core – 17, Functional Analysis	5	4
		Core – 18, Topology - II	5	4
		Core – 19, Project	10	10
		Total	120 hrs.	90

- In Elective- 1, if 1.3. Python Programming-Theory is chosen then in Elective-2, 2.3. Python Programming-Practicals is Compulsory.
- Project credit is increased to create awareness on Research among students.

EVALUATION SCHEME

Theory Papers

Total – 100 Marks Passing Minimum : 50 Marks

INTERNAL : 25 Marks (Passing Minimum : 12 Marks)

Continuous Internal Assessment Tests(Three Tests) : 15 Marks

Seminar : 05 Marks

Assignment : 05 Marks

EXTERNAL : 75 Marks (Passing Minimum : 38 Marks)

Part A - 10 Questions (Objective Type) : $10 \times 1 = 10$ Marks

Part B - 05 Questions (either or) : $05 \times 5 = 25$ Marks

Part C - 05 Questions (either or) : $05 \times 8 = 40$ Marks

Practicals (Python Programming)

Total – 100 Marks Passing Minimum : 50 Marks

INTERNAL **:** 50 Marks

EXTERNAL **:** 50 Marks

Eligibility for admission to the course and examination:

Candidates shall be admitted to the course provided if they have obtained Bachelor's Degree in Mathematics.

Medium of instruction and examination:

The Medium of instruction as well as examination will be English

MODEL QUESTION PAPER

Class : I M.Sc. Mathematics Max Marks 75

Subject : Analysis – I Time : 3 hrs

Answer ALL questions:

PART – A (1×10 = 10 marks)

1. If every point of X is a limit point of E or a point of E, then E is
   (a) open (b) bounded
   (c) perfect (d) dense
2. A metric space is called separable if it contains a _____dense subset.
   (a) countable (b) uncountable
   (c) perfect (d) none of these

3. $[1+\frac{(-1)^n}{n}]$ converges to
   (a) 1 (b) 0
   (c) 2 (d) none of these
4. $\sum_{n=1}^{\infty}\frac{1}{n!} =$ _____
   (a) 1 (b) e
   (c) $\frac{1}{e}$ (d) π
5. $\sum\frac{z^n}{n!}$ has the radius of convergence
   (a) ∞ (b) 0
   (c) e (d) none of these
6. The series
   (a) converges (b) diverges
   (c) oscillates (d) none
7. Monotonic functions have _____discontinuities of the second kind.
   (a) no (b) only one
   (c) many (d) infinite number
8. The function $f(x)=\begin{cases}1, & x\ is\ rational\\ 0, & x\ is\ irrational\end{cases}$, then f is
   (a) continuous (b)discontinuous of first kind
   (c) discontinuous of 2nd kind (d) none
9. The function $f(x)=\begin{cases}x^2\sin\frac{1}{x}, & x\neq 0\\ 0, & x=0\end{cases}$, then f ′(0) is
   (a) 1 (b) 0
   (c) -1 (d) does not exist
10. Let f be defined for all real x and suppose $|f(x)-f(y)|\leq(x-y)^2$ for all real a and y, then f is
   (a) monotonically increasing (b) monotonically decreasing
   (c) constant (d) none

PART – B (5×5 = 25 marks)

11.(a) Prove that closed subsets of compact sets are compact.

(OR)

(b) If *p* is a limit point of a set *E*, then prove that every neighborhood of *E* contains infinitely many points at *E*.

12. (a) Examine the convergence of the product of two convergent sequences.

(OR)

(b) Prove that the sub sequential limits of a sequence $\{p_n\}$ in a metric space *X* form a closed subset of *X*.

13. (a) Show that $\sum\frac{1}{n^p}$ converges if $p > 1$ and diverges if $p \leq 1$.

(OR)

(b) Prove that *e* is irrational.

14. (a) Let *f* be monotonic on (*a,b*). Prove that the set of points of (*a,b*)at which *f* is discontinuous is atmost countable.

(OR)

(b)Prove that a mapping *f* of a metric space *X* into a metric space *Y* is continuous on *X* if and only if $f^{-1}(V)$ is open in *X* for every open set *V* in *Y*.

15. (a) State and prove the chain rule for differentiation.

(OR)

(b) State and prove the generalized mean value theorem

PART – C (8×5 = 40 marks)

16. (a) show that every *k*-cell is compact.

(OR)

(b) State and prove Heine-Borel theorem.

17. (a) Prove that $\lim_{n\to\infty}(1+\frac{1}{n})^n = e$.

(OR)

(b) State and prove Merten's theorem.

18. (a) State and prove Ratio test.

(OR)

(b) State and prove the root test for convergence of a series.

19. (a) If *f* and *g* are real valued continuous functions on a metric space *X*, show that *f+g* and *fg* are also continuous functions.

(OR)

(b) Prove that every continuous function on a compact space is uniformly continuous.

20. (a) State and prove L'Hospital's rule.

(OR)

(b) State and prove Taylor's theorem.

	PART-A	**PART-B**	**PART-C**
Cognitive Level	2,6,7,10	11(a),14(a), 15(a)	16(a), 17(b), 18(a), 19(a)
Understanding Level	1,4,8	11(b). 12(b), 13(a), 14(b), 15(b)	16(b). 18(b), 19(b), 20(a)
Problem solving	3,5,9	12(a), 13(b)	17(a), 20(a)

PROGRAMME OUTCOMES (POs)

The M.Sc. Mathematics programme will enable the students to

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems. and to draw conclusions from the analysis.
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with the society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices.
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAM SPECIFIC OUTCOMES (PSOS)

After successful completion of the programme, a student will be able to:

PSO1	Have deep understanding and knowledge in the core areas of Mathematics.
PSO2	Demonstrate understanding and application of concepts/ theories/ principles/ methods/ techniques in different areas of pure and applied Mathematics.
PSO3	Have capability to read and understand mathematical texts.
PSO4	Demonstrate and communicate mathematical knowledge effectively and unambiguously through oral and/or written expressions.
PSO5	Attain skills of computing /programming /using software tools /formulating models.
PSO6	Attain abilities of critical thinking, logical reasoning, investigating problems, analysis and problem solving.
PSO7	Application of mathematical methods/ techniques, disciplinary knowledge so as to develop skills to solve mathematical problems in other disciplines and/ or in the real world.
PSO8	Development of intellectual capabilities to get into further research in the discipline.
PSO9	Have strong foundation in basic and applied aspects of Mathematics so as to venture into jobs in scientific and various industrial sectors and/or teaching career in Mathematics.
PSO10	Development of strong oral and written communication skills promoting the ability to present ideas and also promote team work spirit.

MSU / 2021-2022 / PG-College / M.Sc. (Mathematics) / Semester - I / Course No. 1/Core-1

Title of the Course : **ALGEBRA - I** (90 Hours)

Course Objective :To inculcate the ideologies of Algebra.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate competence with the basic ideas of algebra including the concepts of counting principle and Homomorphisms	K-2
CO 2	Understand the concept of Cayley's theorem and about Solvable group	K-3
CO 3	Able to demonstrate about the permutations and Accounting principle	K-3
CO 4	Appreciate the significance of Sylow's theorem and Galois theory	K-4
CO 5	Acquire the knowledge of direct products, finitely generated abelian groups	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: A Counting Principle - Normal Subgroups and Quotient Groups -Homomorphisms.
Sections: 2.5 - 2.7. (19hours)

Unit II: Automorphisms - Cayley's Theorem-Solvable Groups.
Sections: 2.8, 2.9.
Supplementary Problems: 10-17. (19 hours)

Unit III: Permutation Groups - Another Counting Principle.
Sections: 2.10, 2.11. (18 hours)

Unit IV: Sylow's Theorems.
Sections: 2.12. (17 hours)

Unit V: Direct Products - Finite Abelian Groups.
Sections: 2.13, 2.14. (17 hours)

Text Book **:**Topics in Algebra**,** I.N. Herstein, 2nd Edition, Wiley India Edition.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021- 2022 / PG-College / M.Sc. (Mathematics) / Semester - I / Course No. 2 /Core-2

Title of the Course **: ANALYSIS - I** (90 Hours)

Course Objective **:**To identify compact sets, connected sets, continuity of functions and derivatives of functions.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Understand the need of metric spaces, compact sets and connected sets.	K-2
CO 2	Able to recognize the convergence of sequence of functions.	K-4
CO 3	Analyze the root test, ratio test, power series, absolute convergence and algebra of series.	K-4
CO 4	Interpret knowledge about the concept of limits and continuity of functions.	K-2
CO 5	Able to know another equally important main ideas namely differentiation and make use of the study of velocity and acceleration of continuous paths.	K-2, K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Metric Spaces – Compact sets – Perfect sets – Cantor sets – Connected sets.
Chapter 2: Sections 2.15 - 2.47. Exercise Problems: 5 - 14, 20. (18 hours)

Unit II: Convergence sequences – Subsequences – Cauchy sequence – Lower and Upper limits – Some Special Sequences – Series – Series of nonnegative terms,the number **e**
Chapter 3: Sections 3.1 - 3.32. Exercise Problems: 1 - 8. (18 hours)

Unit III: Root Test and Ratio Test – Power series – Summation by parts – Absolute Convergence – Addition and Multiplication of Series.
Chapter 3: Sections 3.33 - 3.51. Exercise Problems: 9, 11 – 13. (18 hours)

Unit IV: Continuity-Limit of Functions – Continuous Functions– Continuity and Compactness – Continuity and Connectedness – Discontinuous - Monotonic Functions.
Chapter 4: Sections 4.1 - 4.31. Exercise Problems:1- 5, 14, 15. (18 hours)

Unit V: Differentiation –Derivative of a Real Function – Mean Value Theorems-The Continuity of Derivatives – L' Hospital Rule – Derivatives of Higher Order – Taylor's Theorem.
Chapter 5**:** Sections 5.1 - 5.15. Exercise Problems:1 - 5 and 12. (18 hours)

Text Book: Principles of Mathematical Analysis**,** Walter Rudin, Third Edition,McGraw Hill International Book Company.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022 /PG-College /M.Sc. (Mathematics) /Semester - I / Course No. 3 /Core - 3

Title of the Course **: ANALYTIC NUMBER THEORY** (90 Hours)

Course Objective **:** To Analyse Arithmetic, multiplicative and Chebyshev's functions

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Study the basic concepts of elementary number theory	K-2
CO 2	Explain several arithmetical functions and construct their relationships	K-2, K-3
CO 3	Apply algebraic structure in arithmetical functions	K-3
CO 4	Demonstrate various identities satisfied by arithmetical functions	K-3
CO 5	Determine the application to μ(n) & ∧(n) and several equivalent form of prime number theorem	K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:reating.

L	T	C	P
6	0	4	0

Course Description

Unit I: The Fundamental Theorem of Arithmetic.
Chapter 1 and Exercise Problems: 1 - 11. (18 hours)

Unit II: Arithmetic Functions.
Chapter 2: Sections 2.1 - 2.8.
Exercise problems: 1 - 6. (18 hours)

Unit III: Multiplicative Functions and Dirichlet Multiplication.
Chapter 2: Sections 2.9 – 2.14.
Exercise problems: 21 - 23, 25, 26. (18 hours)

Unit IV: Averages of Arithmetical Functions.
Chapter 3: Sections 1- 9.
Exercise problems:1 - 4. (18 hours)

Unit V: Partial sums of Dirichlet Product, Chebyshev's Functions – Equivalent forms of Prime Number Theorem.
Chapter 3: Sections: 3.10, 3.11, Chapter4: Sections 4.1 – 4.5.
Exercise problems: Chapter4: (3, 4, 5,8, 9, 10). (18 hours)

Text Book: Introduction to Analytic Number Theory – Tom M. Apostol -Springer,International Student Edition.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	3	2	2	3
CO 2	3	3	2	2	3	3	3	2	2	3
CO 3	3	3	2	3	2	2	3	3	2	2
CO 4	2	2	3	3	3	2	2	2	3	2
CO 5	3	3	2	2	3	2	2	3	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022 /PG-College/ M.Sc. (Mathematics) / Semester - I / Course No. 4 /Core-4

Title of the Course **: OPERATIONS RESEARCH** (90 Hours)

Course Objective : To distinguish Transportation models with Inventory theory and Queueing Theory.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Be able to build and solve Transportation and Assignment problems using appropriate method	K-2
CO 2	Learn the constructions of network and optimal scheduling using CPM and PERT	K-3
CO 3	Ability to construct linear integer programming models and solve linear integer programming models using branch and bound method	K-3
CO 4	Understand the need of inventory management.	K-3
CO 5	To understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Transportation Models and its Variants: Definition of the Transportation Model – Non-Traditional Transportation Model– Transportation Algorithm – The Assignment Model.
Chapter 5: Sections 5.1, 5.2, 5.3, 5.4. Exercise problems. (18 hours)

Unit II: Network Analysis: Network Definitions – Minimal Spanning Tree Algorithm –Shortest Route Problem – Maximum Flow Model – CPM –PERT.
Chapter 6: Sections 6.2, 6.3, 6.4, 6.5, 6.7. Exercise problems. (18 hours)

Unit III: Integer Linear Programming: Introduction – Applications –Integer Programming Solutions – Algorithms.
Chapter 9: Sections 9.1, 9.2, 9.3. Exercise problems. (18 hours)

Unit IV: Inventory Theory: Basic Elements of an Inventory Model –Deterministic Models: Single Item Stock Model With And Without Price Breaks –Multiple Items Stock Model With Storage Limitations – Probabilistic Models: Continuous Review Model-Single Period Models.

Chapter 11 – Sections 11.1, 11.2, 11.3, Chapter 16 –Sections 16.1, 16.2, 16.3 Exercise problems. (18 hours)

Unit V: Queuing Theory: Basic Elements of Queuing Model – Role of Poisson and Exponential Distributions – Pure Birth and Death Models – Specialised Poisson Queues - (M/G/1): GD/∞/∞)-Pollaczek - Khintechine Formula. Chapter 17: Sections 17.2, 17.3, 17.4, 17.6, 17.7. Exercise problems. (18 hours)

Text Book: Operations Research (Sixth Edition), Hamdy A. Taha, Prentice Hall of India Private Limited, New Delhi.

Book for Reference:

Operations Research: Principles and Applications, Second Edition, G. Srinivasan, Easrern Economy Edition, PHI

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	3	2	2	3
CO 2	3	3	2	2	3	3	3	2	2	3
CO 3	3	3	2	3	2	2	3	3	2	2
CO 4	2	2	3	3	3	2	2	2	3	2
CO 5	3	3	2	2	3	2	2	3	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022 /PG-College /M.Sc. (Mathematics) /Semester - I / Course No. 5 /Core - 5

Title of the Course **: ORDINARY DIFFERENTIAL EQUATIONS** (90 Hours)

Course Objective : To evaluate solutions of homogeneous equations, Legendre polynomials and Bessel function.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Develop ways of finding explicit solutions of second order linear equations and understand the nature and properties.	K-2, K-3
CO 2	Recall an algebraic function and create attention to the general homogeneous second order linear equation.	K-3
CO 3	Confront the theoretical side of the problem, adapt to the technical task of defining the Legendre polynomial and build their special properties.	K-3
CO 4	Make use of many important applications of Legendre polynomials to mathematical physics. Define the more important Bessel functions and prove some of their simpler properties.	K-3,K-5
CO 5	Specialize the linear system	K-4, K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Second Order linear equations: General solution of the Homogeneous Equations– The use of a known solution to find another – The method of variation of parameters.
Sections: 14 – 16. (18 hours)

Unit II: Power series solutions: A review of power series solutions – Series solution of first order equations – Second order equations – Ordinary points.
Sections: 26 – 28. (18 hours)

Unit III: Regular singular points–Legendre polynomials- Properties of Legendre Polynomials
Sections: 29, 30, 44, 45. (18 hours)

Unit IV: Bessel functions – The Gamma functions – Properties of Bessel functions. Sections: 46, 47. (18 hours)

Unit V: Linear systems: Homogeneous linear systems with constant coefficients Sections: 55, 56 (18 hours)

Text Book: Differential Equations with application and Historical Notes, G.F. Simmons, Second Edition, Tata McGraw Hill.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	3	2	2	3
CO 2	3	3	2	2	3	3	3	2	2	3
CO 3	3	3	2	3	2	2	3	3	2	2
CO 4	2	2	3	3	3	2	2	2	3	2
CO 5	3	3	2	2	3	2	2	3	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022 /PG-College /M.Sc. (Mathematics) / SEMESTER - II / Course No. 6 /Core – 6

Title of the Course **: ALGEBRA - II** (75 Hours)

Course Objective : To recognise Ring homomorphism, Ideals, Radicals and Direct sum of rings.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate competence with the basic ideas of algebra including the concepts of ideals and quotient Rings.	K-2
CO 2	Understand the concept of the Particular Euclidean ring.	K-3
CO 3	Able to demonstrate about the Polynomial rings over Commutative rings.	K-3
CO 4	Appreciate the significance Radicals	K-3
CO 5	Acquired the knowledge of direct sum of rings	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analysing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Ring Homomorphisms – Ideals and Quotient Rings – More Ideals and Quotient Rings– The field of Quotients of an Integral Domain
Text 1: Sections: 3.3 – 3.6 (15 hours)

Unit II: Euclidean Rings – A Particular Euclidean Ring.
Text 1: Sections: 3.7 and 3.8 (15 hours)

Unit III: Polynomial Rings – Polynomials over Rational Field – Polynomial Rings over Commutative Rings
Text 1: Sections: 3.9 – 3.11. (15 hours)

Unit IV: Certain Radicals of a Ring – Jacobson Radical of a Ring –Semisimple Ring – Nil Radical – Primary Ring.
Text 2: Chapter 8: Definition 8.1 –Theorem 8.15. (15 hours)

Unit V: Quasi regular – J-semi simple – Direct sum of rings
Text 2: Chapter 8: Theorem 8.16–Theorem 8.18 and Chapter 10. (15 hours)

Text book:

1. Topics in Algebra, I.N. Herstein, 2nd Edition, Wiley Student edition
2. A First Course in Rings and Ideals, David M. Burton, Addison -Wesley Publishing Company.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College / M.Sc. (Mathematics) /SEMESTER - II / Course No. 7 /Core-7

Title of the Course **: ANALYSIS - II** (75 Hours)

Course Objective : To describe Integrals of functions, Uniform convergence, Power series and Fourier series.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Construct the integration of real valued functions on intervals.	K-2, K-3
CO 2	Explain the integration of vector valued functions and make use of geometric interest with application.	K-2, K-3
CO 3	Explain a new mode of convergence, pointwise convergence with integration , equicontinuous function and pointwise bounded sequence.	K-3
CO 4	Developing properties of polynomials and deriving properties of function represented by power series.	K-3
CO 5	Explain the algebraic completeness of the complex field, its generalization and its conclusion.	K-2, K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Definition and Properties of Integral – Integration and Differentiation.
Chapter 6: Section: 6.1 - 6.22 Exercise Problems: 1,2,4,5,10,11.(15 hours)

Unit II: Integration of vector valued functions – Rectifiable arcs, Sequence and Series of functions: Discussion of main problem – Uniform Convergence – Uniform convergence and Continuity.
Chapter 6: section 6.23 - 6.27 & Chapter 7: Section: 7.1 – 7.15.
Exercise Problems: Chapter 7: 1,4,6 and 7. (15 hours)

Unit III: Uniform Convergence and Integration –Uniform Convergence and Differentiation – Equicontinuous Families of Functions.
Chapter 7: Section 7.16 - 7.25 (15 hours)

Unit IV: The Stone Weierstrass Theorem – Power series.
Chapter 7: Section 7.26 - 7.33 and Chapter 8: Section 8.1 - 8.5.
Exercise Problems: Chapter 8: 1 - 5 (15 hours)

Unit V: The Algebraic Completeness of the Complex Field –Fourier Series –The Gamma function.
Chapter 8: Section 8.8 - 8.22.
Exercise Problems: Chapter 8: 13, 14, 15. (15 hours)

Text Book: Principles of Mathematical Analysis, Third Edition, Walter Rudin –McGraw Hill International Book Company.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022 /PG-College /M.Sc. (Mathematics) /SEMESTER - II / Course No. 8 / Core-8

Title of the Course **: ADVANCED CALCULUS** (75 Hours)

Course Objective :To identify Definite integrals, Differentiation, inverse transformation and transformation of multiple integrals

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Understand the difference between a multiple integral and an iterated iterated integrals and move from one to the other	K-2, , K-3
CO 2	Organise with functions whose range of values will be points in m space, for some specific choice of m such as 2 or 3.	K-3
CO 3	Use linear and affine transformation as local approximations to a general transformation.	K-4
CO 4	Deviate from the older traditional approach and adopt one which is of greater significance of applications in analysis.	K-3,K-4
CO 5	Show how to translate between the language and notation of the system of differential forms and that of vector analysis.	K-3, K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Integration: The Definite Integral – Evaluation of Definite Integrals
Chapter 4: Sections 4.2, 4.3. (15 hours)

Unit II: Differentiation of Transformations: Transformations-Linear Functions and Transformations-Differentials of Transformations
Chapter 7: Sections 7.2 – 7.4 (15 hours)

Unit III: Inverse of Transformations–The Implicit Function Theorems-Functional Dependence.
Chapter 7: Sections 7.5, 7.6, 7.7 (15 hours)

Unit IV: Applications to Geometry and Analysis: Set Functions-Transformations of Multiple Integrals – Curves and Arc Length.
Chapter 8: Sections 8.2, 8.3, 8.4 (15 hours)

Unit V: Differential Geometry and Vector Calculus: Vector Analysis -The Theorems of Green, Gauss and Stokes.
Chapter 9: Sections 9.3, 9.4 (15 hours)

Text Book:

Advanced Calculus, R. Creighton Buck, Third Edition, Tata McGraw Hill, International Student edition.

Book for Reference:

Principles of Mathematical Analysis, Walter Rudin, Third Edition, McGraw Hill International Book Company.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College /M.Sc. (Mathematics) /SEMESTER - II/ Course No. 9/Core-9

Title of the Course **: DIFFERENTIAL GEOMETRY** (75 Hours)

Course Objective : To build the concept of a surface and analyse the properties of surface

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Interpret the geometric character of curves in Space ($\mathbf{R}^3$)	K-2
CO 2	Explain the n^{th} order of a curve and a surface, Develop the plane of curvature at a point of the surface	K-2,K-3
CO 3	Build the concept of a surface and fundamental forms	K-3
CO 4	Explain the intrinsic and non intrinsic properties of a surface	K-3
CO 5	Analyse the properties of a surface relative to the Euclidean space in which it is embedded	K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: The Theory of Space Curves- Definitions, Arc length –Tangent –Normal and Binormal – Curvature and Torsion.
Chapter 1: Section 1.1 – 1.5.
Problems: Chapter 1: Miscellaneous Exercise I: 1 - 3. (15 hours)

Unit II: Contact between Curves and Surfaces – Tangent Surface – Involutes and Evolutes – Helices
Chapter 1: Section 1.6,1.7 and 1.9.
Problems : Chapter 1: Miscellaneous Exercise I:8 –12 (15 hours)

Unit III: Definition of a Surface – Curves on a Surface – Helicoids –Metric – Direction coefficients
Chapter 2: Section: 2.1, 2.2, 2.4, 2.5, 2.6.
Problems: Chapter 2: Miscellaneous Exercise II: 1 – 4. (15 hours)

Unit IV: Families of Curves – Geodesics, Canonical Geodesic Equation, Normal Property of Geodesics (Christoffel symbols not included).
Chapter 2: Section: 2.7, 2.10 – 2.12.
Problems: Chapter 2: Miscellaneous Exercise II: 6,7,8. (15 hours)

Unit V: Geodesic Curvature, The Second Fundamental Form–Principal curvature–Lines of Curvature (Dupin's indicatrix not included).
Chapter 2: Section 2.15, Chapter 3: Section: 3.1 - 3.3.
Problems: Miscellaneous Exercise III: 1 - 5. (15 hours)

Text book: An Introduction to Differential Geometry, T.J. Willmore, Oxford University Press, (17th Impression), New Delhi,2002, (Indian Print).

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	2	2	2	2	2	3	2
CO 2	3	2	2	2	2	2	2	3	3	2
CO 3	2	2	3	2	2	2	2	3	2	2
CO 4	2	2	3	3	2	2	2	3	2	2
CO 5	2	3	3	2	2	3	3	2	2	2

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College /M.Sc. (Mathematics) /SEMESTER - II / Course No. 10 /Core-10

Title of the Course **: RESEARCH METHODOLOGY AND STATISTICS** (75 Hours)

Course Objective : To explain different components of a Research Project, Multivariate functions and various distributions.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Discuss the information of the sections in a dissertation or thesis	K-6
CO 2	Discuss the distributions of two random variables, conditional Distributions and expectations, independent random variables and its generalizations	K-6
CO 3	Build the Gamma and Chi-Square Distributions and Normal Distributions	K-3
CO 4	Classify the distributions of Functions of Random Variables and define three additional distributions of statistical inference	K-3, K-4
CO 5	Build an alternative procedure around the concept of the moment generating - function of a distribution and establish the central limit theorem	K-3,K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Different components of a Research Project – Title page – Abstract- Acknowledgement - List of Contents – Introduction- Literature Review -Methodology –Style of Presentation – Conclusions – Bibliography– Appendices.
Chapter 6:Section 6.1–6.4, 6.6, 6.7, 6.8.1, 6.9.1, 6.11–6.13 in Text 1.
(15 hours)

Unit II: Multivariate Distributions: Distributions of Two Random Variables –Conditional Distributions and Expectations – Independent Random Variables –Extension to Several Random Variables.
Chapter 2: Sections 2.1, 2.3, 2.4, 2.6. in Text 2 (15 hours)

Unit III: Some Special Distributions: The Gamma and Chi – Square Distribution –The Normal Distribution.
Chapter 3: Sections 3.3, 3.4 in Text 2.
Exercise Problems: Chapter 3: 3.28 – 3.33, 3.40 – 3.46. (15 hours)

Unit IV: Sampling Theory: Transformation of Variables – t & F Distributions.
Chapter 4: Sections 4.1 – 4.4 in Text 2**.**
ExerciseProblems:Chapter 4:4.1–4.8,4.14–4.17,4.20–4.25,4.34–4.41
(15 hours)

Unit V: Random Variables: The MGF technique – Distributions of $\bar{\chi}$ and $\frac{ns^2}{\sigma^2}$
-Expectations of Functions of Random Variables – The Central Limit Theorem.
Chapter 4: Section 4.7 – 4.9 & Chapter 5: Section 5.4 in Text 2
Exercise Problems:Chapter 4:4.68–4.74, 4.83–4.93, Chapter 5:5.20–5.22, 5.25–5.27. (15 hours)

Text Book:

1. Writing up your University Assignments and Research Projects – A Practical Handbook, Neil Murray and Geraldine Hughes, McGraw Hill Open University Press.
2. Introduction to Mathematical Statistics, Eighth Edition, Robert V, Hogg and Allen T. Craig, Pearson Education Asia.

Books for Reference:

1. Research Methodology (2nd Revised Methods and Techniques Edition) – C. R. Kothari, New Age International Publications, New Delhi.
2. Fundamentals of Mathematics Statistics – S. C. Gupta, V. K. Kapoor, Eleventh Edition 2002, Sultan Chand& Sons Publishers, New Delhi.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	2	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	3	3	2	2	3
CO 3	2	3	2	3	2	3	3	3	3	3
CO 4	2	3	3	3	2	3	3	3	2	3
CO 5	2	3	3	3	2	3	3	2	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022 /PG-College /M.Sc. (Mathematics) /SEMESTER - II /Course No. 11/Elective-1.1

Title of the Course **: CLASSICAL MECHANICS** (75 Hours)

Course Objective : To illustrate Mechanics of a system of particle, Hamilton principle and Kepler problem

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Distinguish between the external force acting on the particles due to sources outside the system and internal forces on all other particles in the system.	K-2, K-3
CO 2	Work with many vector forces and accelerations and deal with two scalar functions.	K-3
CO 3	Emphasize that configuration space has no necessary connection with the physical three-dimensional space. extend Hamilton's principle to cover certain types of nonholonomic systems.	K-4
CO 4	Discuss the problems of two bodies moving under the influence of a mutual central force as an application of the Lagrangian formulation.	K-3
CO 5	Solve the orbital equation for motion in a central inverse-square force law in a fairly straightforward manner with results that can be stated in simple closed expressions.	K-4, K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Mechanics of particles– Mechanics of a system of particle constraints.
Chapter 1: Section 1 - 3, Problems: 2, 4 and 5. (15 hours)

Unit II: D'Alembert's Principle and Lagrange's Equation – Velocity dependent potentials and dissipation functions – Simple applications of Lagrangian formulation.
Chapter 1: Section 4, 5 and 6, Problems: 11, 13 and 17. (15 hours)

Unit III: Hamilton's Principle – Some techniques of Calculus of Variation –Derivation of Lagrange's equations from Hamilton's principle – Extension of Hamilton principle to non-holonomic systems.

Chapter 2: Section 1 – 4, Problems: 1 – 3. (15 hours)

Unit IV: Reduction to the equivalent one-body problem – The equations of motion and first Integrals – The equivalent one-dimensional problem and classification of orbits – The virial theorem.
Chapter 3: Section 1 – 4, Problems: 2 – 4. (15 hours)

Unit V: The differential equation for the orbit and integrable power law potentials – The Kepler problem: Inverse square law of force – The motion in time in the Kepler problem – The Laplace – Runge – Lenz vector.
Chapter 3: Section 5, 7 – 9. (15 hours)

Text Book: Classical Mechanics, H. Goldstein, Second Edition, Addison Wesley India Edition.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	2	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	3	3	2	2	3
CO 3	2	3	2	3	2	3	3	3	3	3
CO 4	2	3	3	3	2	3	3	3	2	3
CO 5	2	3	3	3	2	3	3	2	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 202120-22 / PG-College / M.Sc. (Mathematics) /SEMESTER -II/Course No. 11 /Elective-1.2

Title of the Course **: PARTIAL DIFFERENTIAL EQUATIONS** (75 Hours)

Course Objective : To analyse various methods of solutions of Partial differential equation, Cauchy's Method and Separation of variables

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Find the fundamental difference between Pfaffian differential equations in two variables and those in a higher number of variables.	K-3, K-4
CO 2	Find the general solution of a linear partial differential equation and indicate how such a general solution may be used to determine the integral surface which passesthrough a given curve.	K-4, K-5
CO 3	Able to solve the nonlinear partial differential equation.	K-5
CO 4	Able to solve linear partial differential equations of the second order.	K-5
CO 5	Able to extend the characteristic curves of a second - order linear differential equation in two independent variables to the case where there are n independent variables.	K-3, K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Methods of Solution of $\frac{dx}{P}+\frac{dy}{Q}+\frac{dz}{R}$– Pfaffian Differential Forms and Equations- Solution of Pfaffian Differential Equations in three variables.
Chapter 1: Section: 3, 5 and 6 (all problems) (15 hours)

Unit II: Partial Differential equations – Origins of first order Partial Differential equations –Linear equations of the first order –Integral surfaces passing through a given curve.
Chapter 2: Section: 1, 2, 4 and 5 (all problems) (15 hours)

Unit III: Cauchy's Method of Characteristics – Compatible systems of First order Equations –Charpit's Method.
Chapter 2: Section: 8 – 10 (all problems) (15 hours)

Unit IV: Second order equations in Physics – Linear Partial Differential equations with Constant Coefficients.
Chapter 3: Section: 2 and 4 (all problems) (15 hours)

Unit V: Characteristics of Equations in three variables – Separation of variables.
Chapter 3: Section: 7 and 9 (all problems) (15 hours)

Text Book: Elements of Partial Differential Equations, IAN N. SNEDDON,McGraw Hill,New Delhi,1983

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	3	2	2	3
CO 2	3	3	2	2	3	3	3	2	2	3
CO 3	3	3	2	3	2	2	3	3	2	2
CO 4	2	2	3	3	3	2	2	2	3	2
CO 5	3	3	2	2	3	2	2	3	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2020-2021/PG-Colleges/M. Sc. (Mathematics)/SEMESTER - II/ Course No. 11/Elective 1.3

Title of the Course **: PYTHON PROGRAMMING** (75 Hours)

Course Objective : To demonstrate Problem Solving Techniques, Algorithmic Problem Solving , Python introduction and Python functions.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Give mathematical model for real world problems	K-1, K-2
CO 2	Design algorithms for mathematical models, analyse the efficiency and correctness of algorithms.	K-4
CO 3	Design implementable programs in Python.	K-5
CO 4	Define and demonstrate the use of functions and looping using Python.	K-3
CO 5	Design and implement a program to solve a real-world problem.	K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: PROBLEM SOLVING TECHNIQUES

Problem solving Techniques – Algorithm, flowchart, pseudocode, programming; Algorithms: properties, quality (time, space); building blocks of algorithms - statements, state, control flow, functions, notation (pseudo code, flow chart, programming language) (15 hours)

Unit II: ALGORITHMIC PROBLEM SOLVING

Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), pseudocode for some Mathematical Problems – greatest of two numbers, print n natural numbers, greatest common divisor, fibonacci sequence upto n terms. Practical applications of algorithms.

(15 hours)

Unit III: INTRODUCTION TO PYTHON

Introduction to Python, Python interpreter, Modes of Python Interpreter, Values and Data Types, Variables, Keywords, Identifiers, Statements and Expressions, Input and Output, Comments, Docstring, Lines and Indentation, Quotation, Tuple Assignment, Operators and Types of Operators, Operator Precedence. (15 hours)

Unit IV: PYTHON FUNCTIONS

Functions, Types of function, Function definition (Sub program), Flow of Execution, Function Prototypes, Parameters and Arguments; Modules; Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion. (15 hours)

Unit V: STRING, LISTS, TUPLES IN PYTHON

Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value. (15 hours)

Text Book:

Allen B. Dowley, "Think Python: How to Think Like a Computer Scientist", 2nd Edition.

Reference Books:

1. Wes McKinney, **"**Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython", O'Reilly, 2nd Edition, 2018.
2. Jake VanderPlas, "Python Data Science Hand Book: Essential Tools for working with Data", O'Reilly, 2017.
3. Wesley J. Chun, "Core Python Programming", Prentice Hall, 2006.
4. Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2009.

E-Books:

http://www.programmer-books.com/introducing-data-science-pdf/
http://www.CS.uky.edu/~keen/115/haltermanpythonbook.pdf
http://math.ecnu.edu.cn/~lfzhou/seminar/IJoel Geusl Datascience from Scratch First Princ.pdf

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	3	3	3	3	3
CO 2	3	2	3	3	2	3	3	3	3	3
CO 3	3	2	3	3	3	3	3	3	3	3
CO 4	3	2	3	3	3	3	3	3	3	3
CO 5	2	2	2	3	3	3	3	3	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022/PG-Colleges/M.Sc. (Mathematics)/SEMESTER - III/ Course No. 12/Core-11

Title of the Course **: ADVANCED ALGEBRA - I** (90 Hours)

Course Objective : To paraphrase vector space, Jordan form, Matrices and Transformations

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Construct the process to develop the fundamental notations of linear dependence, basis and dimensions.	K-3
CO 2	Develop the concepts about linear transformation and matrix theory	K-3
CO 3	Discover the existence of linear transformation in similarities	K-4
CO 4	Identify the theorems about linear transformations, canonical form of matrices and fundamental properties of matrices	K-3
CO 5	Classify the behaviour of Hermitian, Unitary and Normal transformations.	K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6: Creating

L	T	C	P
6	0	4	0

Course Description

Unit I: Vector spaces: Dual spaces- Inner product space- modules
Sections: 4.3 – 4.5. (18 hours)

Unit II: Linear transformations: The Algebra of linear transformations –Characteristic roots– Matrices.
Sections: 6.1 – 6.3. (18 hours)

Unit III: Canonical Forms: Triangular form – Nilpotent form – Jordan form
Sections: 6.4 - 6.6 (18 hours)

Unit IV: Matrices: Canonical Forms – Rational Canonical Form –Trace and transpose– Determinants.
Sections: 6.7 – 6.9 (18 hours)

Unit V: Transformations: Hermitian, unitary and normal transformations, Real Quadratic Forms.
Section: 6.10 (Up to Lemma 6.10.11), 6.11 (18 hours)

Text Book: Topics in Algebra, I.N. Herstein (Second Edition) Wiley Eastern Limited.

Book for Reference:

1. A course in Abstract algebra (3^{rd}Edition)- Vijay.K. Khanna, S.K. Bhambri – Vikas Publishing House – New Delhi.
2. Fields and Rings – Kaplemsky, Irving (Second Edition) – University of Chicago – Chicago – (1972).

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022/PG-College/M.Sc. (Mathematics)/SEMESTER - III/ Course No. 13 /Core-12

Title of the Course **: GRAPH THEORY** (90 Hours)

Course Objective : To illustrate Graphs with trees, Euler tour, Hamilton cycles and vertex and edge colouring.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate the concept of different structures and types about graphs and explain its applications	K-2,K-3
CO 2	Determine the properties of trees and applications in network and study the concepts of connections in graphs	K-2,K-3
CO 3	Acquire the knowledge about Euler Tours, Hamilton Cycles and matchings in Graphs	K-3
CO 4	Analyze the concept of edge coloring ,independent sets and cliques in Graphs	K-4
CO 5	Explain the concept of vertex colorings	K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Graphs and Subgraphs.

Chapter 1: Section: 1.1 – 1.8 (18 hours)

Unit II: Trees – Connectivity.

Chapter 2: Section: 2.1 – 2.5. and Chapter 3: Section 3.1 – 3.3 (18 hours)

Unit III: Euler tour – Hamilton cycle – Matching.

Chapter 4: Section: 4.1 – 4.3, Chapter 5: Section 5.1 – 5.3 (18 hours)

Unit IV: Edge colouring – Independent sets – Cliques

Chapter 6: Section 6.1, 6.2 and Chapter 7: Section 7.1–7.3. (18 hours)

Unit V: Vertex Colouring.

Chapter 8: Section 8.1 – 8.5. (18 hours)

Text Book: Graph Theory with Applications, H.J.A. Bondy and Murthy, The MacMillan Press Limited.

Mapping:

Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	2	3	2	2	3
CO 2	2	3	3	2	3	2	3	3	2	3
CO 3	2	3	3	2	2	3	3	2	2	3
CO 4	2	3	3	2	3	3	3	3	3	3
CO 5	3	3	2	2	2	2	3	3	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/ 2021-2022 /PG-College / M.Sc. (Mathematics) /SEMESTER - III/Course No. 14 /Core-13

Title of the Course **: MEASURE AND INTEGRATION** (90 Hours)

Course Objective : To analyse Lebesgue Measure, Lebesgue outer measure, Lebesgue integrals and Signed Measures

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Establish the basics for Lebesgue measurable functions and the Lebesgue integral. characterise on inner approximation by closed sets and on outer approximation by open sets.	K-4
CO 2	Establish results regarding the approximation of measurable functions by simple functions and by continuous functions.	K-4, K-5
CO 3	Exhibit a uniform bounded sequence of Riemann integrable functions on a closed, bounded interval can converge pointwise to a function that is not Riemann integrable.	K-4
CO 4	Provide a characterization of the class of functions on closed, bounded intervals that may be expressed as the difference of increasing functions.	K-3, K-4
CO 5	Abstract the most important properties of Lebesgue measure on the real line in the absence of any Topology.	K-3, K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Lebesgue Measure: Lebesgue Measure –Lebesgue Outer Measure-The σ - Algebra of Lebesgue Measurable sets –Outer and Inner Approximation of Lebesgue Measurable sets – Countable Additivity, Continuity and the Borel – Cantelli Lemma.

Chapter 2: Section 2.1 – 2.5. Problems: Chapter 2: 1 – 12 and 17 (18 hours)

Unit II: Lebesgue Measurable functions and Sequential Pointwise Limits and Related Theorems: Lebesgue Measurable functions – Sums, Products and Compositions. Sequential pointwise Limits and Simple

Approximation–Littlewood'sThree Principles,Egoroff's Theorem and Lusin's Theorem

Chapter 3: Section 3.1 – 3.3. Problems: Chapter 3: 1 – 3 (18 hours)

Unit III: Lebesgue Integration: Lebesgue Integration – The Riemann Integral –The Lebesgue Integral of a bounded Measurable function over a set of finite Measure –The Lebesgue Integral of a Measurable non – negative function.

Chapter 4: Section 4.1 – 4. (18 hours)

Unit IV: Lebesgue Integral and Differentiability: The general Lebesgue Integral– Countable Additivity and Continuity of Integration. Differentiation and Integration – Continuity of monotone functions – Differentiability of monotone function: Lebesgue's theorem –Functions of bounded variations: Jordan's theorem.

Chapter 4: Section 4.4 & 4.5 Chapter 6: Section 6.1 – 6.3 (18 hours)

Unit V: Absolutely continuous functions and Signed Measures*:* Absolutely continuous functions – Integrating Derivatives: Differentiating Indefinite Integrals. Measure and Integration – Measures and Measurable sets –Signed Measures: The Hahn and Jordan Decompositions – The Caratheodory measure induced by an outer measure –The construction of outer measure

Chapter 6: Section 6.4 & 6.5 Chapter 17: Section 17.1 – 17.4 (18 hours)

Text Book: Real Analysis, H.L.Royden, P.M.Fitzpatrick, Fourth Edition, PHI Learning Private Ltd.

Book for Reference:

Real Analysis Third Edition (PHI)- H. L. Royden Prentice Hall of India Private Limited– New Delhi (2006).

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022 /PG-College / M.Sc. (Mathematics)/SEMESTER - III / Course No. 15 /Core-14

Title of the Course **: TOPOLOGY – I** (90 Hours)

Course Objective : To relate Topology with various kinds such as Product topology , Metric topology and to learn compactness and limit points, local compactness.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate an understanding of the concepts of topological spaces, construct topologies on a set. Understand the natural generalization of open and closed sets, limit points for the real line and Euclidean space onto the Topological Spaces.	K-2
CO 2	Extend the concept of continuity and various properties of continuous functions; and define a topology on the cartesian products of topological spaces.	K-3
CO 3	Define the metric topology using a metric on the set, give examples for metric topology and prove the properties of any metric topology.	K-4
CO 4	Acquire knowledge of the concepts of separation, connectedness, covering and open covering of a topological space and compactness for a topological space.	K-4
CO 5	Appreciate the importance of a weaker form of compactness called Limit point compactness, local compactness and one-point compactification and identify spaces where Limit point compactness coincides with compactness.	K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Topological spaces: Topological spaces–Basis for a Topology–The Order Topology –The subspace Topology- Closed sets and limit points.
Chapter 2: Sections: 12-14 and 16, 17.
Problems: Section 13: 1, 4, 16: 4, 6, and 17: 1, 11-13 (18 hours)

Unit II: Product Topology: The Product Topology on X×Y–Continuous functions–Product topology
Chapter 2:Section 15,18,19. Problems: Section 18: 2,3 and 19: 1-3.(18 hours)

Unit III: Metric Topology: Metric Topology

Chapter 2: Section 20, 21. Problems: Section 20:1-3 and 21:1, 2. (18 hours)

Unit IV: Some Spaces in Topological Spaces: Connected spaces–Compact Spaces.
Chapter 3:Sections: 23, 26. Problems: Section 23: 2-4 and 26: 3, 6.(18 hours)

Unit V: Compactness: Limit point compactness – Local compactness.
Chapter 3: Section 28, 29. Problems: Section 29: 2, 3. (18 hours)

Text Book: Topology (Second Edition), James R. Munkres, Prentice –Hall of India

Books for Reference:

1. Introduction to General Topology – K.D Joshi Wiley Eastern Limited (1986)
2. Topology – K. Chandrasekara Rao, Narosa Publishing House New Delhi (2009)

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022/PG-College/M.Sc.(Mathematics)/SEMESTER-III/Course No. 16/Elective-2.1

Title of the Course **: ALGEBRAIC NUMBER THEORY** (90 Hours)

Course Objective : To appreciate the significance of approximating irrational numbers, acquired the knowledge of Unique factorizations

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate competence with the basic ideas of Diophantine and other linear equations.	K-2
CO 2	Solve some special equations of the type $x^4+y^4=z^2$	K-3
CO 3	Able to demonstrate about infinite continued functions	K-3
CO 4	Appreciate the significance of approximating irrational numbers	K-3
CO 5	Acquired the knowledge of Unique factorizations	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Diophantine equations: Diophantine equations – The equation ax+by=c – Positive solutions – Other linear equations. (18 hours)

Unit II: Some special equations: The equation $x^2 + y^2 = z^2$ - The equation $x^4 + y^4 = z^2$ –The equation $4x^2 + y^2 = n$ (18 hours)

Unit III: Infinite continued functions: The equations $ax^2 + by^2 + cz^2 = 0$ -Infinite continued functions – Irrational numbers. (18 hours)

Unit IV: Quadratic Fields: Approximation to irrational numbers – Algebraic integers. (18 hours)

Unit V: Unique Factorization – Units in quadratic fields. (18 hours)

Text book: An introduction to the Theory of Numbers – Ivan Nivan and Herbert S. Zukerman – II edition, Wiley Eastern Ltd.

Chapter 5,6 and 9 (except 5.13, 5.14, 7.7,7.8 and 7.9)

Book for reference:

Elements of Number Theory – Kumaravelu and Suseela Kumaravelu (2002), Raja Shankar Printers, Sivakasi (V edition)

Mapping:

Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	2	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	3	3	2	2	3
CO 3	2	3	2	3	2	3	3	3	3	3
CO 4	2	3	3	3	2	3	3	3	2	3
CO 5	2	3	3	3	2	3	3	2	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College /M.Sc. (Mathematics)/SEMESTER - III /Course No. 16 / Elective-2.2

Title of the Course **: CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS** (90 Hours)

Course Objective : To identify Constraints, Linear Equations and various theorems.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate competence with the basic ideas Maxima and Minima	K-2
CO 2	Explain about Constraints and Lagrange's Multipliers Hamilton's principles-Lagrange equations	K-3
CO 3	Demonstrate Relation between differential and integral equations	K-3
CO 4	Appreciate the significance of Fredholm equations with separable kernels	K-3
CO 5	Acquired the knowledge of Iterative methods for solving equations of second kind	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
6	0	4	0

Course Description

Unit I: Calculus of Variations and Applications Maxima and Minima – The simplest case – Illustrative examples-The variational notation-the more general case. (18 hours)

Unit II: Constraints and Lagrange's Multipliers – Variable endpoints - Sturm Liouville problems-Hamilton's principles - Lagrange equations (18 hours)

Unit III: Integral Equations – Introduction –Relation between differential and integral equations – The Green's function - Alternative definition of Green's function. (18 hours)

Unit IV: Linear Equations in cause and effect - The influence function – Fredholm equations with separable kernels – Illustrative Examples. (18 hours)

Unit V: Hilbert Schmidt theory – Iterative methods for solving equations of second kind-Fredholm theory. (18 hours)

Text Book: Methods of Applied Mathematics, Francis B. Hildebrand, sections 2.1to 2.11, 3.1 to 3.9 and 3.11.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	2	3	3	3	3	3	2	3
CO 2	3	3	3	3	3	3	3	2	2	3
CO 3	2	3	2	3	2	3	3	3	3	3
CO 4	2	3	3	3	2	3	3	3	2	3
CO 5	2	3	3	3	2	3	3	2	2	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022/PG-Colleges/M. Sc (Mathematics)/Semester-III/ Course No. 16/Elective-2.3

Title of the Course **: PYTHON PROGRAMMING – PRACTICALS** (90 Hours)

Course Objective : To evaluate GCD of numbers, various sorts, search and to generate an adjacency martix.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Write programs using advanced concepts of Python.	K-3
CO 2	Write, Test and Debug Python Programs.	K-4
CO 3	Implement Conditionals and Loops for Python Programs.	K-5
CO 4	Use functions and represent Compound data using Lists, Tuples and Dictionaries.	K-4
CO 5	Read, write and manipulate data from & to files in Python.	K-5

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6: Creating

L	T	C	P
0	0	4	6

Course Description

LIST OF PRACTICALS IN PYTHON PROGRAMMING:

1. Find minimum/maximum in a list / guess an integer in given range
2. Distance between two points
3. Find GCD
4. Sum an array of numbers
5. Linear search
6. Binary search.
7. Find the numbers which are divisible by n in a given range
8. Print first n Fibonacci numbers
9. Selection sort
10. Insertion sort
11. Merge sort
12. Count word frequencies
13. Generate adjacency matrix of any graph on n vertices
14. Find degree of vertices from given adjacency matrix of the graph
15. Find odd number in given array/ Replace odd numbers with given integer in the given array

16. Compute multiplication of two 3x3 matrices
17. Compute mean and standard deviation of given array
18. Create a Barplot/Piechart for comparing three features.

Text Book:

1. Allen B. Dowley, "Think Python: How to Think Like a ComputerScientist", 2nd Edition.
2. Wes McKinney, "Python for Data Analysis: DataWrangling with Pandas, NumPy, and Ipython", O'Reilly, 2nd Edition, 2018.
3. Jake VanderPlas, "Python Data Science Hand Book: Essential Tools for working with Data", O'Reilly, 2017.

Reference Books:

1. Wesley J. Chun, "Core Python Programming", Prentice Hall, 2006.
2. Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2009.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	3	3	2	3	3	3	3	3
CO 2	3	2	3	3	2	3	3	3	3	3
CO 3	3	2	3	3	3	3	3	3	3	3
CO 4	3	2	3	3	3	3	3	3	3	3
CO 5	2	2	2	3	3	3	3	3	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU/2021-2022/PG-Colleges/M. Sc. (Mathematics)/SEMESTER - IV/ Course No. 17/Core-15

Title of the Course **: ADVANCED ALGEBRA - II** (75 Hours)

Course Objective : To construct extension fields, Finite fields and to learn Four-square theorem

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Build the knowledge with the relation of one field to another	K-3
CO 2	Develop the construction of an extension field K of F in which the polynomial f(x)ϵF[x] have all its roots and study the nature of roots of f(x)	K-3
CO 3	Study the relationship between the roots of a polynomial with its Galois Group and examine it	K-2, K-4
CO 4	Determine the nature of fields having only a finite number of elements	K-5
CO 5	Understand the classification of all division rings R in their centre and satisfy the condition. Also study the Left Division Algorithm and Lagrange's Theorem	K-2, K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit 1: Extension fields: Extension fields
Sections: 5.1. Problems:5.1(1-5, 8) (15 hours)

Unit II: Roots of polynomials. More about roots
Sections: 5.3, 5.5. Problems: 5.5(1-3) (15 hours)

Unit III: Elements of Galois Theory
Sections: 5.6 (15 hours)

Unit IV: Finite fields: Finite fields -Wedderburn's theorem (First proof only)

Sections: 7.1 ,7.2 (Theorem 7.2.1-First proof only) (15 hours)

Unit V: Some special theorems: A theorem of Frobenius-Integral quaternions and the Four-square theorem.
Sections: 7.3, 7.4. (15 hours)

Text Book: Topics in Algebra, I.N. Herstein (Second edition) Wiley Eastern Limited.

Books for Reference:

1. A course in Abstract Algebra (3^{rd} Edition) – Vijay.K. Khanna, S.K. Bhambri-Vikas Publishing House-New Delhi.
2. Modern Algebra - Surjeet Singh and Qazi Zameeruddin-Vikas Publishing House-Newdelhi.
3. Fields and Rings- Kaplemsky, Irving (Second Edition)-University of Chicago-Chicago- (1972).

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College /M.Sc. (Mathematics) / SEMESTER - IV / Course No. 18 /Core-16

Title of the Course **: COMPLEX ANALYSIS** (75 Hours)

Course Objective : To learn Analytic functions, Line integral and Residue theorem.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Extend Calculus to Complex domain.	K-4
CO 2	Develop the fundamentals of point set Topology and Metric Space.	K-4
CO 3	Distinguish between definite and indefinite integrals. familiar with the theory of definite integrals of real continuous functions.	K-5
CO 4	Able to study the local properties of an analytic function in great detail.	K-4, K-5
CO 5	Classify the isolated singularities of analytic functions.	K-4

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Analytic functions: Analytic functions–Polynomials Rational Functions-Power series
Chapter 2: Section 2.1.2 – 2.1.4 & Section 2.2 .4
Problems: Chapter 2:2.1.2 (1,4,5,7) 2.2.4 (2- 6). (15 hours)

Unit II: Conformal mappings: Linear transformations–the linear group-The cross ratio-Symmetry
Chapter 3: Section 3.2.3, 3.3.1 – 3.3.3,
Problems: Chapter 3: 3.3.1 (4); 3.3.2 (1,4) 3.3.3 (1,2,4); (15 hours)

Unit III: Complex Integration: Line integrals –Line integrals as functions of arc - Cauchy's theorem for a Rectangle -Cauchy's theorem in a disc
Chapter 4: Section 4.1.1, 4.1.3 - 4.1.5 (15 hours)

Unit IV: Cauchy's Integral formula: Index of a point with respect to closed curve– The integral formula - Higher derivatives -Local Properties of Analytical Functions: Removable Singularities -Taylor's Theorem- Zeros and Poles
Chapter 4: Section 4.2.1- 4.2.3; 4. 3.1 – 4.3.2
Problems: Chapter 4: 4.2.2 (1-3)
Problems: Chapter 4:4. 2.3 (1), 4.3.2(2 – 4) (15 hours)

Unit V: The Calculus of ResiduesThe Residue theorem-The Argument Principle–Evaluation of definite integrals.
Chapter 4: Section 4.5.1 – 4.5.3
Problems: Chapter 4: 4.5.2(1-3) ,4.5.3 (1, 3(a- g)) (15 hours)

Text Book: Complex Analysis **–** Lars V. Ahlfors – Tata McGraw Hill (Third Edition)

Book for Reference:

Foundations of Complex Analysis – S. Ponnusamy – Narosa Publishing House 2015 (Second Edition).

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU /2021-2022/PG-College /M.Sc. (Mathematics) / SEMESTER - IV / Course No. 19 /Core-17

Title of the Course **: FUNCTIONAL ANALYSIS** (75 Hours)

Course Objective : To describe Banach Space,Hilbert space and various operators

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Make use of the uniform boundedness theorem in the conjugate of an operator on a Banach Space.	K-2, K-3
CO 2	Able to determine the natural imbedding of N in N**	K-5
CO 3	Examine the properties of the mapping from the operator on a normed linear space to its conjugate. understand the importance of operators such as self adjoint and normal operators.	K-3, K-4
CO 4	Able to focus on fixed but arbitrary Hilbert space.	K-2, K-3
CO 5	Analogy between the set of all operators on Hilbert space and the set of all complex numbers.	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Banach Spaces: Banach Spaces- The definition and some examples-Continuous linear transformations- The Hahn Banach Theorem.
Chapter 9:Sections 46,47,48. Problems:Section 46(1,2),47(1,2),48(1). (15 hours)

Unit II: Imbedding: The Natural Imbedding of N in N**- The open mapping theorem.
Chapter 9: Sections 49, 50 Problems: Section 49 (2,3), 50 (2,3) (15 hours)

Unit III: Hilbert Spaces: Conjugate of an operator -Hilbert Spaces-The Definition and some simple properties- Orthogonal complements.
Chapter 9: Section 51, Chapter 10: Sections 52, 53
Problems: Section 51 (1,3) 52 (4,6), 53 (1-3). (15 hours)

Unit IV: The Conjugate space and adjoint: Orthonormal sets-The conjugate space H*-The Adjoint of an operator- Self adjoint operators.

Chapter10: Sections 54,55,56. Problems: Section 54(1,5) 55(1,2), 56(2-4). (15 hours)

Unit V: Operators: Self adjoint operators- Normal and Unitary operators-projections. Chapter 10:Sections 57,58,59. Problems: Section 57(1,2),58(1,3), 59(1,4). (15 hours)

Text Book: Introduction to Topology and Modern Analysis-G.F.SIMMONS,McGraw-Hill International Editions

Books for Reference:

1. Functional Analysis - Second Edition (2011), Tata McGraw Hill Education Private Ltd. (New Delhi) – Walter Rudin.
2. Functional Analysis – K.Chandrasekara Rao, Narosa Publishing House (2009) New Delhi.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 /PG-College/ M.Sc. (Mathematics) / SEMESTER - IV / Course No. 20 /Core-18

Title of the Course **: TOPOLOGY - II** (75 Hours)

Course Objective : To distinguish Separation, countability axioms and to learn various lemmas.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Demonstrate understanding of the concepts of countable, First countable space, Second countable space, Lindelof space, Separable space and Regular space.	K-2
CO 2	Appreciate the concepts of normal space and derive normality from other spaces, and understand the Urysohn Lemma and completely regular definition.	K-2, K-4
CO 3	Prove the Urysohn metrization theorem, Imbedding theorem, Tietze extension theorem and explain the relation between Tietze extension theorem and Urysohn Lemma.	K-4
CO 4	Prove elementary properties of locally finite collection and metrizable spaces, with understanding of Maximality with respect to the finite intersection property and the Tychonoff theorem.	K-4
CO 5	Explain Baire spaces, complete metric space, compact Hausdorff spaces and the relation between these spaces. Apply theoretical concepts in topology to understand some applications.	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	0	4	0

Course Description

Unit I: Separation axioms: The countability axioms – Separation axioms.
Chapter 4: Sections 30, 31.
Problems: Section 30: 2,3 and Section 31: 1-3. (15 hours)

Unit II: The Urysohn lemma: Normal spaces – The Urysohn lemma.
Chapter 4: Sections 32, 33.
Problems: Section 32: 1, 3, 4 and Section 33: 1-2. (15 hours)

Unit III: Urysohn and Tietz extension theorem: The Urysohn metrization theorem – The Tietz extension theorem.
Chapter 4: Sections 34, 35.
Problems: Section 34: 1, 3 and Section 35: 1, 3. (15 hours)

Unit IV: The Tychonoff theorem: The Tychonoff theorem–Local finiteness.
Chapter 5: Sections 37 and Chapter 6: Section 39
Problems: Section 37: 1,2 and Section 39: 3,5. (15 hours)

Unit V: Baire Spaces:
Chapter 8: Section 48, Problems: Section 48: 1,3,4,6 (15 hours)

Text Book: Topology (Second edition), James R. Munkres, Prentice – Hall of India

Books for reference:

1. Introduction to General Topology – K.D. Joshi Wiley Eastern Limited (1986)
2. Topology – K.Chandrasekara Rao Narosa Publishing House 2009(New Delhi)

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0

MSU / 2021-2022 / PG-College / M.Sc. (Mathematics) / SEMESTER - IV / Course No. 21 /Core - 19

Title of the Course **: PROJECT**(150 Hours)

Course Objective : To enrich the research interest and to create innovative ideas.

Course Outcomes(COs)

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

	Course outcome	Cognitive Level
CO 1	Differentiate primary and secondary data and questionnaire	K-2
CO 2	Explain about research methodology	K-3
CO 3	Read articles and write a new article.	K-3
CO 4	Know about the bibliography	K-3
CO 5	Know how to write dissertations and present a paper in conferences.	K-3

K-1: Remembering; K-2: Understanding; K-3: Applying; K-4: Analyzing; K-5: Evaluating; K-6:Creating.

L	T	C	P
5	5	10	0

- ➢ Project credit is increased, to enrich the research interest and to create innovative ideas among students.
- ➢ After Post graduation, the students may pursue research and hence they are expected to participate in seminars, workshops and in conferences.
- ➢ Maximum marks can be awarded to the students who have presented papers in conferences/seminars and who possess publications.

Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	2	3	3	3	3	2	2	3
CO 2	3	3	2	3	3	3	3	2	2	3
CO 3	3	3	2	3	3	3	3	2	2	3
CO 4	3	3	2	3	3	3	3	3	2	3
CO 5	3	3	2	3	3	3	3	2	3	3

Strongly Correlated-3; Moderately Correlated-2; Weakly Correlated-1; No Correlation-0