Table – 6**:** Course Structure for **M.Sc. (Maths) Degree Programme**

(with effect from the academic year 2017-2018 onwards)

Sem. **(1)**	**Sub. No.** **(2)**	**Subject Status** **(3)**	**Subject Title** **(4)**	**Contact Hrs./ Week** **(5)**	**Credits** **(6)**
I	1	Core - 1	Algebra - I	6	4
	2	Core - 2	Analysis – I	6	4
	3	Core - 3	Analytic Number Theory	6	4
	4	Core - 4	Ordinary Differential Equations	6	4
	5	Core - 5	Numerical Analysis	6	4
			Subtotal	**30**	**20**
II	6	Core - 6	Algebra II	5	4
	7	Core - 7	Analysis II	5	4
	8	Core - 8	Classical Mechanics	5	4
	9	Core - 9	Differential Geometry	5	4
	10	Core - 10	Graph Theory	5	4
	11	Elective - 1	1) Programming With C++ 2) Discrete Mathematics 3) Partial Differential Equations	5	3
			Subtotal	**30**	**23**

III	12	Core - 11		5	4
	13	Core - 12		5	4
	14	Core - 13		5	4
	15	Core - 14		5	4
	16	Core - 15	Research Methodology	5	4
	17	Elective - 2		5	3
			Subtotal	**30**	**23**
IV	18	Core - 16		6	4
	19	Core - 17		6	4
	20	Core - 18		5	4
	21	Core - 19		5	4
	22	Core - 20	Project	8	**8**
			Subtotal	**30**	**24**
			Total	**120**	**90**

For the Project, flexible credits are b/w 5 – 8 & Hours per week are b/w 10 - 16.

Total number of credits ≥ 90 : 90
Total number of Core Courses : 20 (19 T + 1 Prj.)
Total number of Elective Courses : 2
Total hours : 120

SEMESTER I

1.1 Paper 1: ALGEBRA - I

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

Unit I: A Counting Principle – Normal Subgroups and quotient groups – Homomorphisms.

Sections: 2.5, 2.6, 2.7.

Unit II: Automorphisms – Cayley's theorem – Solvable groups.

Sections: 2.8, 2.9.
Supplementary Problems : 10 -17.

Unit III: Permutation groups – Another counting principle.
Sections: 2.10, 2.11.

Unit IV: Sylow's theorems.
Sections: 2.12.

Unit V: Direct products – Finite abelian groups.

Sections: 2.13, 2.14.

1.2 Paper 2: ANALYSIS – I

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

Unit I: Metric spaces – Compact sets – Perfect sets – Cantor sets – Connected sets .

Chapter II : Sections 2.15 to 2.47.

Exercise Problems: Chapter II : 5 -14, 20.

Unit II: Convergence sequences – Sub sequences – Cauchy sequence - Lower and Upper limits – Some special sequences – Series – Series of non negative terms – The number e.

Chapter III : Sections 3.1 to 3.32.

Exercise Problems: Chapter III : 1 - 8.

Unit III: Root test and Ratio test – Power series – Summation by parts – Absolute convergence – Addition and multiplication of series.

Chapter III : Sections 3.33 to 3.51.

Exercise Problems : Chapter III : 9, 11 - 13.

Unit IV: Continuity – Limit of functions – Continuous functions – Continuity and compactness – Continuity and connectedness – Discontinuous – Monotonic functions.

Chapter IV : Sections 4.1 to 4.31.

Exercise Problems : Chapter IV: 1 – 5, 14,15.

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 V : Sections 5.1 to 5.15.

Exercise Problems : Chapter V : 1 - 5 and 12.

1.3 Paper 3: ANALYTIC NUMBER THEORY

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

Unit I: The fundamental Theorem of Arithmetic.

Chapter 1 and Exercise Problems: 1-11.

Unit II: Arithmetic functions.

Chapter 2: Sections 2.1 -2.8.

Exercise problems: Chapter 2: (1-6).

Unit III: Multiplicative functions and Dirichlet Multiplication.

Sections 2.9 – 2.14.

Exercise problems: Chapter 2: (21-23, 25,26).

Unit IV: Averages of Arithmetical functions.

Chapter 3: (1-9).

Exercise problems: Chapter 3: (1-4).

Unit V: Partial sums of Dirichlet product, Chebyshev's functions – equivalent forms of prime number theorem.

Chapter 3: Sections: 3.10, 3.11 and **Chapter 4:** 4.1 – 4.5.

Exercise problems: Chapter 4: (3,4,5,8,9,10).

1.4 Paper 4: ORDINARY DIFFERENTIAL EQUATIONS

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

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.

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.

Unit III: Regular singular points – Legendre polynomials- Properties of Legendre polynomials
Sections: 29, 30, 44, 45.

Unit IV: Bessel functions – The Gamma functions – Properties of Bessel functions.
Sections: 46, 47.

Unit V: **Linear systems :** Homogeneous linear systems with constant coefficients
Sections: 55, 56.

1.5 Paper 5: NUMERICAL ANALYSIS

Text Book: Numerical Methods, S. Arumugam and others, Scikech(2001).

Unit I: Interpolation : Newton's Interpolation Formula – Central difference Interpolation Lagrange's Interpolation formula – Divided differences - Newton's Divided differences formula – Inverse Interpolation – Hermit's Interpolating Polynomial.

Chapter 7: Sections 7.1 to 7.7.

Unit II: Numerical differentiation – Derivatives using Newton's forward, backward, central difference formulae

Chapter 8: Sections 8.1 to 8.3.

Unit III: Numerical Integration –Gaussian Quadrature formula –Numerical evaluation of double integrals.

Chapter 8: Sections 8.5 to 8.7.

Unit IV: Numerical solutions of ordinary differential equations – Taylor's series Method – Picard's Method – Euler's Method – Runge Kutta Method.

Chapter 10: Sections 10.1 to 10.4.

Unit V: Predictor corrector Method – Milnes Method – Adams-Bashforth Method.

Chapter 10: Sections 10.5 to 10.7.

SEMESTER II

2.1 Paper 6: ALGEBRA II

Text book 1: Topics in Algebra, I.N. Herstein, 2nd edition, Wiley Student edition.

Text book 2: A First Course in Rings and Ideals, David M. Burton, Addison – Wesley Publishing Company.

Unit I: Ring Homomorphisms – Ideals and Quotient rings – More ideals and Quotient rings – The field of Quotients of an integral domain.

Text book 1: **Sections:** 3.3 – 3.6.

Unit II: Euclidean rings - A particular Euclidean ring.

Text book 1: **Sections:** 3.7 and 3.8.

Unit III: Polynomial rings – Polynomials over rational field – Polynomial rings over commutative rings.

Text book 1: **Sections:** 3.9 – 3.11.

Unit IV: Certain radicals of a ring – Jacobson radical of a ring – Semi simple ring – nil radical – Primary ring.

Text book 2: **Chapter 8:** Definition 8.1 – Theorem 8.15.

Unit V: Quasi regular – J-semi simple – Direct sum of rings.

Text book 2: **Chapter 8:** Theorem 8.16 – Theorem 8.18 and **Chapter 10.**

2.2 Paper 7: ANALYSIS II

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

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

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.

Unit III: Uniform Convergence and Integration – Uniform Convergence and Differentiation – Equicontinuous families of functions.
Chapter 7: Section: 7.16 – 7.25.

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.

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.

2.3 Paper 8: CLASSICAL MECHANICS

Text Book: Classical Mechanics, H. Goldstein, second edition, Addison Wesley India edition.

Unit I: Mechanics of particle – Mechanics of a system of particles constraints.

Chapter 1: **Section** 1-3, Problems: 2, 4 and 5.

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.

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.

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.

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.

2.4 Paper 9: DIFFERENTIAL GEOMETRY

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

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.

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.

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.

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.

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.

2.5 Paper 10: GRAPH THEORY

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

Unit I: Trees - Connectivity – Blocks.
Chapter 2: Section: 2.1 – 2.4. and Chapter 3: Section 3.1 – 3.3

Unit II: Euler tour – Hamilton cycle – Applications.
Chapter 4: Section: 4.1 – 4.3

Unit III: Matching – Perfect Matching – Edge colouring.
Chapter 5: Section: 5.1 – 5.3 & **Chapter 6 :** Sec : 6.1 & 6.2.

Unit IV: Independent sets – Cliques.
Chapter 7: Section: 7.1 – 7.3.

Unit V: Vertex Colouring.
Chapter 8: Section: 8.1 – 8.5.

2.6 Elective(Any One)

2.6.1 PROGRAMMING WITH C++

Text Book: Object oriented Programming with C++ (Fourth Edition), E.Balagurusamy, TMH Publications.

Unit I: Tokens, Expressions and Control Structures.

Chapter: 3

Programming Exercises: 3.1, 3.3, 3.5, 3.7, 3.9, 3.10

Unit II: Functions in C++, Classes & Objects.

Chapter: 4 & 5

Programming Exercises: 4.1, 4.2, 4.5, 4.7, 5.2, 5.5

Unit III: Constructors and destructors, Operator overloading & Type conversions.

Chapter: 6 & 7

Programming Exercises: 6.2, 7.2, 7.3, 7.4

Unit IV: Inheritance – Extending classes, Pointers, Virtual Functions & Polymorphism.

Chapter: 8 & 9

Programming Exercises: 9.1, 9.2

Unit V: Unformatted I/O Operations, Formatted Console I/O Operations, Managing Output with Manipulators, Working with Files.

Chapter: 10.4, 10.5, 10.6, 11

Programming Exercises: 10.1, 10.3, 11.1, 11.2

2.6.2 DISCRETE MATHEMATICS

Text Book: Discrete Mathematics and its Applications (Sixth Edition) – Kenneth H. Rosen. WCB/ McGraw Hill Publications

Unit I: Propositional Logic – Propositional equivalence - Predicates and quantifiers.

Sections: 1.1 - 1.3.

Problems: Section 1.1(1 - 38), Section 1.2(1 - 35) and

Section 1.3(1 – 34)

Unit II: The Basics of counting – The Pigeonhole principle – Generalized permutation and combination.

Sections: 5.1, 5.2 and 5.5

Problems: Section 5.1(1 - 40), Section 5.2(1 - 22) and

Section 5.5(1 – 9)

Unit III: Relation and their properties – n-ary relations and their applications – representing relation – closures of relations.
Sections: 7.1 – 7.4 except Warshall's algorithm
Problems: Section 7.1(All exercise problems), Section 7.2(1 - 27),

Section 7.3(1 – 22) and Section 7.4(1 - 22)

Unit IV: Boolean functions – Representing Boolean functions.
Sections: 10.1 and 10.2
Problems: All exercise problems.

Unit V: Logic Gates –Minimization.
Sections: 10.3 and 10.4
Problems: All exercise problems.

2.6.3 PARTIAL DIFFERENTIAL EQUATIONS

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

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)

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)

Unit III: Cauchy's Method of Characteristics - Compatible systems of First order Equations - Charpit's Method.

Chapter 2: **Section:** 8 - 10 (all problems)

Unit IV: Second order equations in Physics - Linear Partial Differential equations with Constant Coefficients.

Chapter 3: **Section:** 2 and 4 (all problems)

Unit V: Characteristics of Equations in three variables - Separation of variables.

Chapter 3: **Section:** 7 and 9 (all problems)

MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI
PG - COURSES – AFFILIATED COLLEGES
Course Structure for M.Sc Mathematics
(Choice Based Credit System)
(with effect from the academic year 2017- 2018 onwards)

Sem. **(1)**	**Sub. No.** **(2)**	**Subject Status** **(3)**	**Subject Title** **(4)**	**Contact Hrs./ Week** **(5)**	**Credits** **(6)**
III	12	Core - 11	Measure and Integration	6	4
	13	Core - 12	Topology – I	6	4
	14	Core - 13	Advanced Algebra - I	5	4
	15	Core - 14	Operations Research	5	4
	16	Core - 15	Research Methodology	4	4
		Elective – 2 (Any one)	1) Algebraic Number Theory 2) Calculus of Variation and Integral Equations 3) Formal Languages and Automata Theory	4	3
			Subtotal	**30**	**23**
IV	18	Core - 16	Functional Analysis	6	4
	19	Core - 17	Complex Analysis	6	4
	20	Core - 18	Advanced Algebra – II	5	4
	21	Core - 19	Topology - II	5	4
	22	Core - 20	Project	8	**8**
			Subtotal	**30**	**24**
			Total	**120**	**90**

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.12 / Core-11

Measure and Integration (90 Hours)

L	T	P	C
2	4	0	4

Objective:

- Gain the knowledge of measure spaces and measure interruption
- Understanding the concept of lesbeague measure ,lesbeague integration and signed measure
- To provide the understanding of general measure spaces

Prerequisite:

- Basic knowledge of differentiation, integration and continuity of real functions

Outcome:

Knowledge gained about lesbeague theory and general measure spaces and their properties and construction.

Unit I: **LebesgueMeasure:**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 : Sec 2.1 – 2.5

Problems : Chapter 2 : 1 – 12 and 17

L 16

Unit II: **Lebesgue Measurable functions&Sequential pointwise Limits and related Theorems**: Lebesgue Measurable functions – Sums, Products and Compositions. Sequential pointwise Limits and Simple Approximation – Littlewood's Three Principles, Egoroff's Theorem and Lusin's Theorem

Chapter 3 : Sec 3.1 - 3.3 and

Problems :Chapter 3 : 1 – 3

L 19

Unit III: **LebesgueIntegration :**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 : Sec 4.1 – 4.3

L 16

Unit IV: **Lebesgue Integral &Differentiablility**: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 : Sec 4.4 & 4.5
Chapter 6 : Sec 6.1 - 6.3

L 19

Unit V: **Absolutely continuous functions &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 : Sec 6.4 & 6.5
Chapter 17 : Sec : 17.1 - 17.4

L 20

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

Book for Reference:

Real Analysis Third Edition (PHI)-H.L.Royden Prentice hall of ofindia private limited –New Delhi (2006).

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.13 / Core-12

Topology I (90 Hours)

L	T	P	C
2	4	0	4

Objectives:

- To distinguish space by means of Simple Topological invariants
- Gain the knowledge of constructing spaces by giving and to prove that in certain case, that the result is homeomorphic to standard spaces.

Prerequisite:

- Basic knowledge in Set Theory and Analysis at Undergraduate level.

Outcome:

Knowledge gained about Topological Spaces and the theories based on these spaces.

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 and Section 16: 4, 6. Section 17: 1,11-13 L 16

Unit II: **Product topology :**The product topology on $X \times Y$ – Continuous functions – Product topology
Chapter 2: Section 15, 18,19.
Problems: Section 18: 2,3 and Section 19: 1-3. L 18

Unit III: **Metric Topology :**Metric Topology
Chapter 2: Section 20, 21
Problems: Section 20:1-3 and section 21:1, 2. L 19

Unit IV: **Some spaces in topological spaces:**Connected spaces – Compact spaces.
Chapter 3: Sections: 23,26
Problems: Section 23: 2-4 and Section 26: 3, 6. L 20

Unit V: **Compactness :**Limit point compactness – Local compactness.
Chapter 3: Section 28, 29.
Problems: Section 29: 2,3. L 17

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

Books for Reference:

1. Introduction to general Topology – K.D Joshi Willey Eastern Limited (1986)
2. Topology – K.ChandrasekaraRaoNarosa Publishing House New Delhi (2009)

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.14 / Core-13

Advanced Algebra I (75 Hours)

L	T	P	C
3	2	0	4

Objective:

The aim of the paper is to introduce some of the most fundamental algebraic structures like inner product space, Determinants, etc.

Prerequisites:

Basic knowledge in set theory and Matrix theory

Outcome:

After learning this paper the student can understand,

- The notion of Dual Spaces.
- The algebra of Linear transformations.

Unit I: **Vector spaces:**Dual spaces – Inner product spaces.
Sections: 4.3 and 4.4. L 14

Unit II: **Linear transformations:**The Algebra of linear transformations – Characteristic roots – Matrices.
Sections: 6.1 – 6.3. L 17

Unit III: **Canonical Forms:**Triangular form – Nilpotent form – Jordan form.
Sections: 6.4 - 6.6. L 16

Unit IV: **Matrices:**Trace and transpose – Determinants.
Sections: 6.8-6.9 L 14

Unit V: **Transformations:** Hermitian, unitary and normal transformations.
Sections: 6.10(Up to Lemma 6.10.11) L 14

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

Book for Reference:

- A course in Abstract algebra (3rd edition)-Vijay.K.Khanna,S.K.Bhambri – Vikas Publishing House –Newdelhi.
- Fields and Rings –Kaplemsky ,Irving (Second edition)-University of Chicago- Chicago -(1972).

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.15 / Core-14

Operations Research(75 Hours)

L	T	P	C
3	2	0	4

Objectives:

- To modify rual life into Standard Mathematical Models
- To learn different optimization techniques.
- To know classification of different structured problems.

Prerequisite:

Basic computing knowledge and techniques at undergraduate level.

Outcome:

- Identification of actual problems and its equivalent mathematical models.
- Application to different optimization techniques in real life situations.
- Knowledge gained in utilization of Optimum Resources.

Unit I: **Transportation Models And Its Variants:** Definition Of The Transportation Model – Nontraditional Transportation Model – Transportation Algorithm – The Assignment Model.

Chapter 5 – Sections 5.1, 5.2, 5.3, 5.4 and Exercise problems. L 16

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 and Exercise problems. L 15

Unit III: **Integer Linear Programming**: Introduction – Applications – Integer Programming Solutions – Algorithms.

Chapter 9 – Sections 9.1, 9.2, 9.3 and Exercise problems. L 17

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.

Chapter 11 – Sections 11.1, 11.2, 11.3, Chapter 16 – Sections 16.1, 16.2 and Exercise problems. L 12

Unit V: **Queuing Theory:** Basic Elements Of Queuing Model – Role Of Poisson And Exponential Distributions – Pure Birth And Death Models – Specialised Poisson Queues

Chapter 17 – Sections 17.2, 17.3, 17.4, 17.6(upto 17.6.3) and Exercise problems. L 15

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

Books for Reference:

1. Introduction to Operations Research – Fredrick, Shiller, GenraldJ.Literman – MC Graw Hill (2017)
2. Operations Research – KantiSwarup, P.K. Gupta, Man Mohan – Sultan Chand and sons. (2016)
3. Operations Research (Fifth edition) J.N Sharma, McMillian Publications (2013)

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.16 / Core-15

Research Methodology: (60 Hours)

L	T	P	C
4	0	0	4

Objectives:

- To understand the Basic aspects in research
- To learn Mathematical and Statistical technique for research
- To acquire basic knowledge about various instruments and techniques in Mathematical research.

Prerequisite:

Basic knowledge in Statistics and related information to be useful for research.

Outcome:

- Training and participating in active research activities for their academic and professional levels.
- Creation of novel ideas and simple technique useful to society(R/D)
- Acquire background knowledge in research publication and thesis writing.

Unit I : **Research Project :**Research Project – Difference between a dissertation and a thesis– Basic requirements of a research degree –Writing a proposal –Ethical considerations

Chapter 5 : Sec: 5.1, 5.2, 5.3,5.6,5.13 in Text Book 1. L10

Unit II : **Components of a Research Project:**Different components of a research project– Literature review – Methodology – Results / data – Conclusions – Bibliography - Appendices.

Chapter 6 : Sec: 6.1-6.6,6.7,6.8.1, 6.9.1,6.11, 6.12, 6.13 in Text Book 1. L10

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.16 / Core-15

Unit III : **Some Special Distributions :** The Gamma and Chi – Square distribution – The normal distribution.

Chapter 3: Sec: 3.3, 3.4 in Text Book 2.

Exercise Problems:Chapter 3: 3.28 – 3.33, 3.40 – 3.46. L13

Unit IV : **Sampling Theory :** Transformation of variables – t & F distributions.

Chapter 4: Sec : 4.1 – 4.4 in Text Book 2.

Exercise Problems:Chapter 4: 4.1 – 4.8, 4.14 – 4.17, 4.20 – 4.25, 4.34 – 4.41. L14

Unit V : **Random variables:**The MGF technique – Distributions of $\overline{X}$ and $\frac{ns^2}{\sigma^2}$ - Expectations of functions of random variables-The Central Limit Theorem.

Chapter 4: Sec : 4.7 – 4.9 in Book 2. **Chapter 5:** Sec 5.4 in Text Book 2

Exercise Problems: Chapter 4 :4.68 – 4.74, 4.83 – 4.93.

Exercise Problems:Chapter 5:, 5.20 – 5.22, 5.25 – 5.27. L13

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, Fourth 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,Sultanchand& sons Publishers, New Delhi.

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.17 / Elective - 2 (a)

Algebraic Number Theory (60 Hours)

L	T	P	C
2	2	0	3

Objective:

- To acquire knowledge about recent developments in Algebra have its impact on Number Theory and Number Theory too has its own contribution to the development of algebra.
- To understand and appreciate the role played by Algebra in Number Theory.

Prerequisite:

Basic knowledge in Distribution of primes, Mathematical Induction and Congruence..

Outcome:

Knowledge gained about various types of numbers such as algebraic Numbers, Pythagorean triples and representation of number as sum of positive squares.

Unit I: **Diophantine equations :**Diophantine equations – The equation $ax+by=c$ – Positive solutions – Other linear equations. L 12

Unit II: **Some special equations:**The equation $x^2+y^2=z^2$ – The equation $x^4+y^4=z^2$.The equation $4x^2+y^2=n$ L 12

Unit III: **Infinite continued functions :**The equation $ax^2+by^2+cz^2=0$- Infinite continued functions – Irrational numbers. L 13

Unit IV: **Approximation to irrational numbers :**Approximation to irrational numbers- Algebraic integers . L 11

Unit V: **Quadratic Fields :**Quadratic Fields – Units in quadratic fields. L 12

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

Book for Reference:

Elements of Number Theory – Kumaravelu and SuseelaKumaravelu (2002), Raja Shankar Printers,Sivakasi(V Edition).

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.17 / Elective - 2 (b)

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

(60 Hours)

L	T	P	C
2	2	0	3

Objective:

The objective of this paper is to place at the disposal of the student, the basis of an intelligent working knowledge of a number of facts and techniques which are useful in varied fields of application.

Prerequisite:

Basic knowledge in Elementary Matrix Theory, Quadratic forms, Coordinate Transformations.

Outcome:

Gain knowledge in maxima minima techniques and solution of certain types of Integral equations.

Unit I: **Maxima and Minima :**Calculus of Variations and Applications – Maxima and Minima – The simplest case – Illustrative examples.
Exercises problems: Chapter 2(2, 6, 8 and 18)
Sections: 2.1-2.4 L 11

Unit II: **Lagrange's Multipliers**:Thevariational notations – The more general case – Constraints and Lagrange'sMultipliers – Variable end points.
Exercises problems: Chapter 2(19, 20 and 21)
Sections: 2.5-2.8 L 12

Unit III: **Integral Equations:**Integral Equations – Introduction –Relation between differential and integral equations – The Green's function.
Exercises problems: Chapter 3(1,9, 11)
Sections: 3.1-3.3 L 12

Unit IV: **Fredholm equations:** Linear Equations in cause and effect- The influence function -Fredholm equations with separable kernels – Illustrative Examples.
Exercises problems: Chapter 3(40 and 43)
Sections: 3.5-3.7 L 11

Unit V: **Hilbert Schmidt theory:**Hilbert Schmidt theory – Iterative methods for solving equations of second kind.
Exercises problems: Chapter 3(52 and 53)
Sections: 3.8-3.9 L 14

Text Book: **Methods of Applied Mathematics, Francis B. Hilde brand**, Prentice Hall of India, New Delhi.**Sections:** 2.1 to 2.8 and 3.1 to 3.3, 3.5-3.9

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.17 / Elective - 2 (b)

Book for Reference:

Problems and Exercises in integral equations – M.Krarnov, A.Kiselev and G.Makarenko – Mir Publishers, Moscow (1971).

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.17 / Elective - 2 (c)

Formal Languages and Automata Theory(60 Hours)

L	T	P	C
2	2	0	3

Objectives:

This course provides a formal connection between algorithmic problems solving and union of languages and automata and develop them into a mathematical view towards algorithmic design and computation.

Prerequisite:

Basic knowledge in computer operations and languages.

Outcome:

- Be able to understand the basic properties of formal languages
- Be able to understand the basic properties of deterministic and non-deterministic finite automata.

Unit I: **Finite automata, regular expressions :**Finite state Systems – Basic definitions – Non deterministic finite automata – Finite automata with ε moves – Regular expressions.

Chapter 2 : Sec : 2.1 – 2.5. L 11

Unit II: **Properties of regular sets :**The pumping lemma for regular sets – Closure properties of regular sets – Decision algorithms for regular sets – The Myhill-Nerode Theorem and minimization of finite automata.

Chapter 3 : Sec : 3.1 – 3.4 L 12

Unit III: **Context – free grammars :** Motivation and introduction – Context-free grammars – Derivation trees – Simplification of context-free grammars – Chomsky normal form – Greibach normal form.

Chapter 4 : Sec : 4.1 – 4.6 L 13

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -III / Ppr.no.17 / Elective - 2 (c)

Unit IV: **Pushdown automata :** Informal description – Definitions-Pushdown automata and context-free languages.

Chapter 5 : Sec : 5.1 – 5.3 L 11

Unit V: **Properties of context-free languages :** The pumping lemma for CFL's – Closure properties for CFL's – Decision algorithms for CFL's.

Chapter 5: Sec: 6.1 – 6.3 L 13

Text Book : **Introduction to Automata Theory, Languages and Computation,** Jhon E. Hopcraft and Jeffrey D. Ullman, Narosa Publishing House, New Delhi,- 198.

Book for Reference:

1. Introduction to languages & theory of computation – John.C.Martin- Tata Mcgraw hill- 2003.
2. Introduction to Automata theory ,languages and computation- Hopcraft ,Motwan and Ullman-Pearson publisher- Third edition -2006.
3. Elements of the theory of computation-H.R.lewis and C.H.Papadimitrious - Tata Mcgraw hill-2003.

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -IV / Ppr.no.18 / Core - 16

Functional Analysis (90 hours)

L	T	P	C
2	4	0	4

Objective:

- To gain knowledge about Banach Spaces, Hilbert Spaces and Banach Algebra.
- To use algebraic structure in Analysis.

Prerequisite:

Basic knowledge of Metric Spaces, Topology and Sequences.

Outcome:

Graduates will have a strong foundations and in depth understanding of the current topics related with functional Analysis, Spectral Theory, Approximation Theory.

UNIT 1: **BanachSpaces:**Banach Spaces- The definition and some examples-Continuous linear transformations- The Hahn Banach Theorem
Chapter 9 Sections 46, 47, 48 .
Problems: Section 46 (1-4), 47 (1-3) 48 (1). L 17

UNIT 2: **Imbedding :**The Natural Imbedding of N in N**- The open mapping theorem
Chapter 9 Sections 49, 50
Problems: Section 49 (1-3), 50 (2,3) L 18

UNIT 3: **Hilbert Spaces:**Conjugate of an operator -Hilbert Spaces-The Definition and some simple properties- Orthogonal compliments
Chapter 9 Section 51, Chapter 10 Sections 52, 53
Problems: Section 51 (1-3) 52 (4,6), 53 (1-4). L 18

UNIT 4: **The Conjugate space and adjoint**: Orthonormal sets-The conjugate space H*-The Adjoint of an operator- Self adjoint operators
Chapter 10 Sections 54, 55, 56, 57
Problems: Section 54 (1,5) 55 (1-3), 56 (1-4), 57 (1,2) L 18

UNIT 5: **Spectral Theory:**Normal and Unitary operators- projections, Finite dimensional spectral theory- Determinants and the spectrum of an operator- The spectral theorem
Chapter 10 Sections 58, 59, Chapter 11 Sections 61, 62
Problems: Section 58, 59, 61, 62 (1-5) . L 19

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 MC Graw Hill Education Private Ltd. (New Delhi) – Walter Rudin.
2. Functional Analysis – K.ChandrasekaraRao, Narosa Publishing House (2009) New Delhi.

Complex Analysis(90 hours)

L	T	P	C
2	4	0	4

Objectives:

- To gain advanced knowledge about Complex functions and Analytic functions as mappings.
- To understand the concept of Analyticity Conformality, Linear Transformation and Complex Integration.

Prerequisite:

Basic knowledge of concepts of Differentiation and Integration for functions of real variables further in UG level they level the fundamental Ideas and theorems about Complex plane power series residues.

Outcome:

- Acquistation of solving problems in Complex Integration and boundary value problems.

Unit I: **Analytic functions :**Analytic functions – Polynomials – Power series- Abel's limit theorem.

Chapter 2: Sec 1.1 – 1.4, Sec 2 .4 &2.5 .

Problems: Chapter 2: 1.2 (1,4,5,7) 2.4 (2- 6) .

L 20

Unit II: **Conformal mappings :**Conformal mappings - Linear transformations –the linear group – the cross ratio- Symmetry – line integrable – line integrable as functions of arc.

Chapter 3: Sec 2.3, 3.1 – 3.3, **Chapter 4 :** Sec 1.1 – 1.3(1,3,4,5).

Problems:Chapter 3: 3.1 (4); 3.2 (1,4) 3.3 (1,2,4);

L 17

Unit III: **Cauchy's theorem for Rectangle :**Cauchy's theorem for Rectangle – Cauchy's theorem in a disc, Cauchy's Integral formula, Index of a point – The integral formula.

Chapter 4: Sec 1.4 & 1.5, 2.1& 2.2

Problems:Chapter 4 : 2.2 (1-3)

L 16

Unit IV: **Higher derivatives** -Taylor's Theorem :Higher derivatives -Taylor's Theorem – Zeros and Poles – The local mapping – The maximum principle and the general statement of Cauchy's Theorem (Statement only) .

Chapter 4: Sec 2.3, 3.1 – 3.4 and 4.4.

Problems:Chapter 4 : 2.3 (1) , 3.2(2 – 4) L 18

Unit V: **Calculus of Residues:**Calculus of Residues –The Residue theorem - The Argument Principle – Evaluation of definite integrals.

Chapter 4: Sec 5.1 – 5.3 L 19

Problems:Chapter 4: 5.2(1-3) ,5.3 (1, 3(a- g))

Text : 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).

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -IV / Ppr.no.20 / Core - 18

Advanced Algebra II (75 hours)

L	T	P	C
3	2	0	4

Objectives:

Gain knowledge in fields in the theory of numbers,the theory of equations and Galois theory .

Prerequisite:

Knowledge of Groups , Rings and Elementary properties of fields.

Outcome:

Understand the application of Galois theory in theory of equations and Geometry.

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

Unit II: **Roots of polynomials :**Roots of polynomials – More about roots.
Sections: 5.3, 5.5
Problems: 5.5(1-3) L 16

Unit III: **Elements of Galois theory.:**Elements of Galois theory.
Sections: 5.6 L 16

Unit IV: **Finite fields :**Finite fields – Wedderburn's theorem(First proof only)
Sections: 7.1, 7.2(Theorem 7.2.1-First proof only) L 14

Unit V: **Some special theorems:**A theorem of Frobenius – Integral quaternions and the four square theorem.
Sections: 7.3, 7.4. L 14

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

Book for Reference:

- A course in Abstract algebra (3rd edition)-Vijay.K.Khanna,S.K.Bhambri – Vikas Publishing House –Newdelhi.
- Modern Algebra –Surjeetsingha and Qazizameerudin- Vikas Publishing House –Newdelhi.
- Fields and Rings –Kaplemsky ,Irving (Second edition)-University of Chicago- Chicago -(1972).

Topology II(75 hours)

L	T	P	C
3	2	0	4

Objective:

- Gain knowledge in separation axioms in Topological Spaces.
- Understanding the concepts of Normal and Regular Spaces.

Prerequisite:

- Basic Knowledge in Set theory and Analysis at Undergraduate level.
- Knowledge in first course topology and functions in Topological Spaces.

Outcome:

- Improves the standard of understanding Set theory, Analysis and Topology and pave the way to do Research in these areas.

Unit I: **Separation axioms.:** The countability axioms – Separation axioms.
Chapter 4: Sections 30, 31.
Problems: Section 30: 2,3 and Section 31: 1-3. L 16

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. L 15

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. L 17

Unit IV: **The Tychonofftheorem :**TheTychonoff theorem – Local finiteness.
Chapter 5: Sections 37 and Chapter 6: Section 39
Problems: Section 37: 1,2 and Section 39: 3,5. L 15

Unit V: **Baire Spaces.:**Baire Spaces.
Chapter 8: Sections 48.
Problems: Section 48: 1, 3, 4, 6. L 12

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

Books for reference:

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

MSU / 2017-18 / PG –Colleges / M.Sc.(Mathematics) / Semester -IV / Ppr.no.22 / Project

Project C 8

Contact hours -8+

Objective:

- To provide training in scientific skills.
- To prepare students for professional training programme or entry level jobs in any area of Mathematics.

Prerequiste:

- Students should be able to understand and interpret the literature in their areas of research.

Outcome:

At the end of the project the students should have increased

- Their capacity to think critically
- Their ability to design analyse and execute an experiment.
- Their confidence and ability in communication skills(in writing and oral)
- To acquiring the literature collection methods and interpreting the date of their scientific equipment etc.