

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

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

<b>Sem.</b>  <b>(1)</b>	<b>Sub. No.</b>  <b>(2)</b>	<b>Subject Status</b>  <b>(3)</b>	<b>Subject Title</b>  <b>(4)</b>	<b>Contact Hrs./ Week</b>  <b>(5)</b>	<b>Credits</b>  <b>(6)</b>
<b>I</b>	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
	<b>Subtotal</b>				<b>30</b>
<b>II</b>	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
	<b>Subtotal</b>				<b>30</b>

## SEMESTER I

### 1.1 Paper 1: ALGEBRA - I

**Text Book:** Topics in Algebra , I.N. Herstein, 2<sup>nd</sup> 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, 2<sup>nd</sup> 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<sup>th</sup> Impression), 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 – Involutives 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)

<b>Sem .</b> <b>(1)</b>	<b>Sub. No.</b> <b>(2)</b>	<b>Subject Status</b> <b>(3)</b>	<b>Subject Title</b> <b>(4)</b>	<b>Contact Hrs./ Week</b> <b>(5)</b>	<b>Credits</b> <b>(6)</b>
<b>III</b>	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
<b>Subtotal</b>				<b>30</b>	<b>23</b>
<b>IV</b>	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	<b>8</b>
	<b>Subtotal</b>				<b>30</b>
<b>Total</b>				<b>120</b>	<b>90</b>

**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: Lebesgue Measure:** Lebesgue Measure – Lebesgue Outer Measure – The  $\sigma$  - 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
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**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
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**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 :** Sec 4.1 – 4.3

L 16
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**Unit IV: Lebesgue Integral & 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 :** Sec 4.4 & 4.5

**Chapter 6 :** Sec 6.1 - 6.3

L 19
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**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
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**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).

**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
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**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
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**Unit III: Metric Topology :**Metric Topology

**Chapter 2:** Section 20, 21

**Problems:** Section 20:1-3 and section 21:1, 2.

L 19
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**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
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**Unit V: Compactness :**Limit point compactness – Local compactness.

**Chapter 3:** Section 28, 29.

**Problems:** Section 29: 2,3.

L 17
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**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)

**Advanced Algebra I (75 Hours)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4</b>

**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.

<b>Unit I:</b>	<b>Vector spaces:</b> Dual spaces – Inner product spaces. <b>Sections:</b> 4.3 and 4.4.	L 14
<b>Unit II:</b>	<b>Linear transformations:</b> The Algebra of linear transformations – Characteristic roots – Matrices. <b>Sections:</b> 6.1 – 6.3.	L 17
<b>Unit III:</b>	<b>Canonical Forms:</b> Triangular form – Nilpotent form – Jordan form. <b>Sections:</b> 6.4 - 6.6.	L 16
<b>Unit IV:</b>	<b>Matrices:</b> Trace and transpose – Determinants. <b>Sections:</b> 6.8-6.9	L 14
<b>Unit V:</b>	<b>Transformations:</b> Hermitian, unitary and normal transformations. <b>Sections:</b> 6.10(Up to Lemma 6.10.11)	L 14
<b>Text Book:</b>	<b>Topics in Algebra</b> (Second edition) Wiley Eastern Limited – <b>I.N. Herstein</b>	

**Book for Reference:**

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

**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
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**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
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**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)

**Research Methodology: (60 Hours)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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

L10

1.

**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  $\bar{X}$  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( 2<sup>nd</sup> 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.

**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).



**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:**The variational notations – The more general case – Constraints and Lagrange’s Multipliers – 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 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

**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
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**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.Papadimitriious - Tata Mcgraw hill-2003.

**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: 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 (1-4), 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:**

- Acquisition 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 .

L 20

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

**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

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

L 19

**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).

**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 (3<sup>rd</sup> 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
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**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
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**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
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**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.

L 15
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**Unit V: Baire Spaces.:**Baire Spaces.

**Chapter 8:** Sections 48.

**Problems:** Section 48: 1, 3, 4, 6.

L 12
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**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)

**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.

**Prerequisite:**

- 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.