



MANONMANIAM SUNDARANAR UNIVERISTY,  
TIRUNELVELI-12

## SYLLABUS

### PG - COURSES – AFFILIATED COLLEGES

Course Structure for M. Sc. Mathematics

(Choice Based Credit System)

(with effect from the academic year 2023-2024 onwards )



Semester-I				
Part	Subject Status	Subject Title	Subject Code	Credit
3	Core	ALGEBRAIC STRUCTURES	WMAM11	5
3	Core	REAL ANALYSIS I	WMAM12	5
3	Core	ORDINARY DIFFERENTIAL EQUATIONS	WMAM13	4
3	Elective I	GRAPH THEORY AND APPLICATIONS	WMAE11	3
3	Elective II	ANALYTIC NUMBER THEORY	WMAE15	3



**Total Marks: 100 Internal Exam: 25 marks + External Exam: 75 marks**

**A. Scheme for internal Assessment:**

Maximum marks for written test: **15 marks**

**3 internal tests**, each of **1 hour** duration shall be conducted every semester.

To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks and Seminar for 5 marks

The break up for internal assessment shall be:

Written test- 15 marks; Assignment -5 marks; Seminar-5 Marks Total - 25 marks

**B. Scheme of External Examination**

**3 hrs.** examination at the end of the semester

A – Part : 1 mark question two - from each unit

B – Part : 5 marks question one - from each unit

C – Part : 8 marks question one - from each unit

➤ **Conversion of Marks into Grade Points and Letter Grades**

S.No.	Percentage of Marks	Letter Grade	Grade Point	Performance
1	90 - 100	O+	10	Outstanding
2	80 - 89	O	9	Excellent
3	70 - 79	A+	8	Very Good
4	60 - 69	A	7	Good
5	55 - 59	B+	6	Above Average
6	50 - 54	B	5	Pass
7	0 - 49	RA	-	ReAppear
8	Absent	AA	-	Absent

➤ **Cumulative Grade Point Average (CGPA)**

$$CGPA = \frac{\Sigma (GP \times C)}{\Sigma C}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

➤ **Classification**

- First Class with Distinction : CGPA  $\geq$  7.5\*
- First Class : CGPA  $\geq$  6.0
- Second Class : CGPA  $\geq$  5.0 and  $<$  6.0
- Third Class : CGPA  $<$  5.0



# ALGEBRAIC STRUCTURES

## Objectives of the Course

- To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms.

## UNIT - I

Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).

*Chapter 2:* Sections 2.11 and 2.12 (Omit Lemma 2.12.5)

## UNIT - II

Solvable groups - Direct products - Finite abelian groups Modules

*Chapter 5:* Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1),

*Chapter 2:* Section 2.13 and 2.14 (Theorem 2.14.1 only)

*Chapter 4:* Section 4.5

## UNIT - III

Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations.

*Chapter 6:* Sections 6.4, 6.5

## UNIT - IV

Jordan form - rational canonical form.

*Chapter 6:* Sections 6.6 and 6.7

## UNIT – V

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.

*Chapter 6:* Sections 6.8, 6.10 and 6.11 (Omit 6.9)

## Recommended Text

- I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.

## Reference Books

- M.Artin, Algebra, Prentice Hall of India, 1991.
- P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
- I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups (1996); Vol. II Rings, Narosa Publishing House, New Delhi, 1999
- D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
- N.Jacobson, Basic Algebra, Vol. I & II W.H. Freeman (1980); also published by Hindustan Publishing Company, New Delhi.

## Website and e-Learning Source

- <http://mathforum.org>, <http://ocw.mit.edu/ocwwweb/Mathematics>,
- <http://www.opensource.org>, [www.algebra.com](http://www.algebra.com)



## REAL ANALYSIS - I

### Objectives of the Course

- To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.

### UNIT-I

**Functions of bounded variation** - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on  $[a, x]$  as a function of  $x$  - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

*Chapter – 6: Sections 6.1 to 6.8*

**Infinite Series:** Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.

*Chapter 8: Sections 8.8, 8.15, 8.17, 8.18*

### UNIT-II

**The Riemann - Stieltjes Integral** - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Monotonically increasing integrators, Upper and lower integrals – Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.

*Chapter - 7: Sections 7.1 to 7.6, 7.11- 7.14*

### UNIT-III

**The Riemann-Stieltjes Integral** - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable – Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter.

*Chapter - 7: Sections 7.15 to 7.23*

### UNIT-IV

**Infinite Series and infinite Products** - Double sequences -Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products.

*Chapter - 8: Sections 8.20, 8.21 to 8.26*

**Power series** - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem

*Chapter 9: Sections 9.14 9.15, 9.19, 9.20*

### UNIT-V

**Sequences of Functions** – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions – Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence



of infinite series of functions - Riemann – Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.

*Chapter - 9:* Sections 9.1 to 9.6, 9.9, 9.10, 9.11.

### Recommended Text

1. Tom M. Apostol : Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

### Reference Books

1. Bartle, R.G. Real Analysis, John Wiley and Sons Inc., 1976.
2. Rudin, W. Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik, S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
5. Gelbaum, B.R. and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964.
6. A.L. Gupta and N.R. Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.

### Website and e-Learning Source

1. <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
2. <http://www.opensource.org>, [www.mathpages.com](http://www.mathpages.com)

## ORDINARY DIFFERENTIAL EQUATIONS

### Objectives of the Course

To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations

### UNIT-I

**Linear equations with constant coefficients:** Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Nonhomogeneous equation of order two.

*Chapter 2:* Sections 1 to 6

### UNIT-II

**Linear equations with constant coefficients:**

Homogeneous and non-homogeneous equation of order  $n$  –Initial value problems-Annihilator method to solve non-homogeneous equation Algebra of constant



coefficient operators.

*Chapter 2: Sections 7 to 12.*

### UNIT-III

**Linear equation with variable coefficients:** Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.

*Chapter: 3 Sections 1 to 8 (Omit section 9)*

### UNIT-IV

**Linear equation with regular singular points:** Euler equation – Second order equations with regular singular points –Exceptional cases – Bessel Function.

*Chapter 4: Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)*

### UNIT-V

**Existence and uniqueness of solutions to first order equations:** Equation with variable separation – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.

*Chapter 5: Sections 1 to 6 (Omit Sections 7 to 9)*

### Recommended Text

1. E.A.Coddington, A introduction to ordinary differential equations (3<sup>rd</sup> Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

### Reference Books

1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and sons, New York, 1967.
2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.

### Website and e-Learning Source

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2. <http://www.opensource.org>, [www.mathpages.com](http://www.mathpages.com)



# GRAPH THEORY AND APPLICATIONS

## Objectives of the Course

- To understand and apply the fundamental concepts in Graph Theory, to apply Graph Theory based tools in solving practical problems and to improve the proof writing skills.

## UNIT-I

**Basic Result:** Subgraphs – Degrees of Vertices – Paths and Connectedness – Automorphism of a simple graph – Line graphs – Operations on graphs – Graph Products.

*Chapter 1:* Sec 1.1 to 1.9.

## UNIT-II

**Connectivity:** Vertex Cuts and Edge Cuts – Connectivity and Edge Connectivity – Blocks.

*Chapter 3:* Sec 3.1 to 3.4.

## UNIT-III

**Trees:** Definition, Characterization and simple properties - Centres and centroids - counting the number of Spanning Trees -Cayley's formula

*Chapter 4:* Sec 4.1 to 4.5.

## UNIT-IV

**Independent Sets and Matchings:** Vertex – Independent Sets and Vertex Coverings – Edge Independent Sets – Matchings and Factors – Matching in Bi-partite Graphs – Perfect Matching and the Tutte Matrix

*Chapter 5:* Sec 5.1 to 5.6.

## UNIT-V

**Eulerian and Hamiltonian Graphs:** Eulerian Graphs-Hamiltonian Graphs-Hamilton's "Around the World" Game Graph Colorings: Vertex colorings-Applications of Graph Colorings-Critical Graphs-Brooks' Theorem.

*Chapter 6:* Sec 6.1 to 6.3,

*Chapter 7:* Sec 7.1 to 7.3 (up to Brooks theorem).

## Recommended Text

- R.Balakrishnan and K.Ranganathan, Text Book of Graph Theory, Springer Publications, 2012.

## Reference Books

- H.J.A Bondy and U.S.R.Murty. Graph Theory with Applications. North Holland, New York, Amsterdam, Oxford, 2008.
- West, D. B., Introduction to Graph Theory, Pearson Education, 2011.
- Robin J. Wilson, Graph Theory, Pearson Education, Asia 2002.
- P. J. Cameron, J. H. van Lint, Graph Theory, Coding Theory and Block Designs, London Mathematical Society Lecture Note Series (19), Cambridge University Press, Reprint in April 2013.
- Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill, 2007



# ANALYTIC NUMBER THEORY

## Objectives of the Course

- To understand Dirichlet multiplication, a concept which helps clarify interrelationship between various arithmetical functions and also some equivalent forms of the prime number theorem.

## UNIT-I

The Fundamental Theorem of Arithmetic.

*Chapter 1:* Section 1.1 - 1.8

Exercise Problems: *Chapter 1:* 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.

*Chapter 2:* Sections 2.9 – 2.14.

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

## UNIT-IV

Averages of Arithmetical Functions.

*Chapter 3:* Sections 3.1 - 3.9.

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, *Chapter 4:* Sections 4.1 – 4.4.

Exercise problems: *Chapter 4:* 3, 4, 5, 8.

## Recommended Text

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

## Reference Books

1. Problems in Analytic Number Theory, M. Ram Murty, Springer(2001)
2. Steps into Analytic Number Theory, Paul Pollack, Akash Singha Roy, Springer (2021)

