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 2024-2025 onwards)

Semester-II				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
3	Core IV	RING THEORY AND LATTICES		5
3	Core V	REAL ANALYSIS - II		5
3	Core VI	PROBABILITY THEORY		4
3	Elective III	RESEARCH METHODOLOGY/ ALGEBRAIC NUMBER THEORY/ PARTIAL DIFFERENTIAL EQUATIONS		3
3	Elective IV	WAVELETS/ OPERATIONS RESEARCH/ NEURAL NETWORKS		3
3	SEC – I	MATHEMATICAL DOCUMENTATION USING LATEX		2

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 **I 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)

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

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

➢ Classification

a) First Class with Distinction : CGPA $\geq$ 7.5*****
b) First Class : CGPA $\geq$ 6.0
c) Second Class : CGPA $\geq$ 5.0 and $<$ 6.0
d) Third Class : CGPA $<$ 5.0

RING THEORY AND LATTICES

Objectives of the Course

- The aim of the paper is to introduce about Rings and its properties.

UNIT-I

Ring Homomorphisms – Ideals and Quotient Rings – More Ideals and Quotient Rings – The field of Quotients of an Integral Domain

Text 1: Sections: 3.3 – 3.6

UNIT-II

Euclidean Rings – A Particular Euclidean Ring.

Text 1: Sections: 3.7 and 3.8

UNIT-III

Polynomial Rings – Polynomials over Rational Field – Polynomial Rings over Commutative Rings

Text 1: Sections: 3.9 – 3.11.

UNIT-IV

Certain Radicals of a Ring – Jacobson Radical of a Ring –Semisimple Ring – Nil Radical

Text 2: Chapter 8: Definition 8.1 –Theorem 8.10.

UNIT- V

Partially Ordered sets and Lattices- Distributivity and Modularity- The theorem of Jordan Holder - Boolean Algebra

Chapter 8 Sections 8.1-8.3 & 8.5

Recommended Text

1. Topics in Algebra, I.N. Herstein, 2nd Edition, Wiley Student edition
2. A first Course in Rings and Ideals, David M. Burton, Addison - Wesley Publishing Company.
3. Basic Algebra I, Nathan Jacbson Yale University, W.H.Freeman and company. New York, 2nd Edition

REAL ANALYSIS - II

Objectives of the Course

- To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.

UNIT-I

Measure on the Real line - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability

Chapter - 2 Sec 2.1 to 2.5 (de Barra)

UNIT-II

Integration of Functions of a Real variable - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals

Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra)

UNIT-III

Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem – The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesaro Summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

Chapter 11 : Sections 11.1 to 11.15 (Apostol)

UNIT-IV

Multivariable Differential Calculus - Introduction – The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1

Chapter 12 : Section 12.1 to 12.14 (Apostol)

UNIT-V

Implicit Functions and Extremum Problems: Functions with non-zero Jacobian determinants – The inverse function theorem-The C theorem-Extrema of real valued functions of several variables-Extremum problems with side conditions.

Chapter 13: Sections 13.1 to 13.7 (Apostol)

Recommended Text

1. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II)
2. Tom M.Apostol : Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)

Reference Books

1. Burkill,J.C.The Lebesgue Integral, Cambridge University Press, 1951.
2. Munroe,M.E.Measure and Integration. Addison-Wesley, Mass.1971.
3. Royden,H.L.Real Analysis, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
6. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.

Website and e-Learning Source

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org

PROBABILITY THEORY

Objectives of the Course

- To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

UNIT-I

Random Events and Random Variables: Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.

Chapter 1: Sections 1.1 to 1.7

Chapter 2 : Sections 2.1 to 2.9

UNIT-II

Parameters of the Distribution : Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.

Chapter 3 : Sections 3.1 to 3.8

UNIT-III

Characteristic functions : Properties of characteristic functions – Characteristic functions and moments – semi-invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.

Chapter 4 : Sections 4.1 to 4.7

UNIT-IV

Some Probability distributions: One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform– normal gamma – Beta – Cauchy and Laplace (continuous) distributions.

Chapter 5 : Section 5.1 to 5.10

UNIT-V

Limit Theorems : Stochastic convergence – Bernoulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and 6.12.

Recommended Text

1. M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.

Reference Books

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
4. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
5. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
6. B.R.Bhat , Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999

Website and e-Learning Source

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, http://www.probability.net

RESEARCH METHODOLOGY

Objectives of the Course

- To understand the Basic aspects in Research, to learn Mathematical Technique for Research and to acquire basic knowledge about various instruments in Mathematical Research.

UNIT I

To know about writing style - Writing clearly and concisely-Level of formality - Using gender- neutral language - reading other research project
Chapter 3: Section 3.1 – 3.4

UNIT II

Tips and Strategies-Planning carefully-Deciding on your writing approach- Sourcing and selecting information – Recording information/making notes
Chapter 4: Section 4.1 – 4.4.

UNIT III

Research Project: Research Project – Difference between a dissertation and a thesis - Basic requirements of research degree – Writing a proposal – Ethical considerations
Chapter 5 ; Sec 5.1, 5.2, 5.3, 5.6 and 5.13

UNIT IV

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

UNIT V

Publishing and presenting your research and Tool kit- Journal Articles - A book - conference presentation- A final note - All punctuations.
Chapters 7 & 8

Recommended Text

1. Writing up your University Assignments and Research Projects – A Practical Handbook, Neil Murray and Geraldine Hughes, McGraw Hill Open University Press.

ALGEBRAIC NUMBER THEORY

Objectives of the Course

- To appreciate the significance of approximating irrational numbers, acquired the knowledge of Unique factorizations.

UNIT-I

Diophantine equations: Diophantine equations – The equation ax+by=c – Positive solutions – Other linear equations.

UNIT-II

Some special equations: The equation $\square^2 + \square^2 = \square^2$ The equation $\square^4 + \square^4 = \square^2$ – The equation $4\square^2 + \square^2 = \square$

UNIT-III

Infinite continued functions: The equations $\square\square^2 + \square\square^2 + \square\square^2 = 0$ Infinite continued functions – Irrational numbers.

UNIT-IV

Quadratic Fields: Approximation to irrational numbers – Algebraic integers.

UNIT-V

Unique Factorization – Units in quadratic fields.

Recommended Text

1. An introduction to the Theory of Numbers – Ivan Nivan and Herbert S. Zukerman – II edition, Wiley Eastern Ltd.
   Chapter 5,6 and 9 (except 5.13, 5.14, 7.7,7.8 and 7.9)

Reference Books

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

PARTIAL DIFFERENTIAL EQUATIONS

Objectives of the Course

- To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.

UNIT-I

Mathematical Models and Classification of second order equation: Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations

in two independent variables – canonical forms – equations with constant coefficients – general solution
Chapter 2 : Sections 2.1 to 2.6
Chapter 3 : Sections 3.1 to 3.4

UNIT-II

Cauchy Problem: The Cauchy problem –Cauchy- Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.
Chapter 4 : Sections 4.1 to 4.11

UNIT-III

Method of separation of variables: Separation of variable- Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations
Chapter 6 : Sections 6.1 to 6.6

UNIT-IV

Boundary Value Problems: Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle, a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.
Chapter 8 : Sections 8.1 to 8.9

UNIT-V

Green's Function: The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem.
Chapter 10 : Section 10.1 to 10.9

Recommended Text

1. TynMyint-U and Lokenath Debnath, Partial Differential Equations for Scientists and Engineers (Third Edition),North Holland, New York, 1987.

Reference Books

1. M.M.Smirnov, Second Order partial Differential Equations, Leningrad, 1964.
2. I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.

3. R.Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.
4. M.D.Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd., New Delhi, 2001.
5. S.Sankar Rao, Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi. 2004

Website and e-Learning Source

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.mathpages.com

WAVELETS

Objectives of the Course

- To know about wavelet transformation and Fourier transformations, Wavelet series and Fourier series, Cardinal spline spaces and its properties, functions and wavelets and Cardinal spline wavelets.

UNIT-I

An Overview : Fourier to Wavelets – Integral Wavelets Transform and Time frequency analysis – Inversion formulas and duals – Classification of Wavelets – Multi resolution analysis – Spines and Wavelets. Fourier Analysis : Fourier and Inverse Fourier Transformation – Continuous Time Convolution – The delta function – Fourier Transformation of square integrable functions.

UNIT-II

Fourier Analysis (contd): Fourier Series – Basic Convergence Theory– Poisson Summation Formula. Wavelet Transforms and Time Frequency Analysis : The Gabor Transforms – Short time Fourier Transforms and the uncertainty principle – The integral Wavelet Transform – Dyadic Wavelets – Inversion – Frames – Wavelet Series.

UNIT-III

Cardinal Spline Analysis : Cardinal Spline spaces – Bsplines and their basic properties – The time scale relation and an interpolating graphical display algorithm – B-Net representations and computation of cardinal splines – Constructions of cardinal splines – constructions of spline application formulas – Construction of Spline interpolation formulas

UNIT-IV

Functions and Wavelets : Multi-resolution analysis – Scaling functions with finite

two scale relation – Direction sum Decompositions of L2 (□) - Wavelets and their duals

UNIT-V

Cardinal Splines Wavelets : Interpolating splines wavelets – Compactly supported spline – Wavelets – Computation of Cardinal spline Wavelets – Euler –Frebenious Polynomials – Orthogonal Wavelets : Examples of orthogonal Wavelets – Identification of orthogonal two scale symbols – Construction of compactly supported orthogonal wavelets.

Recommended Text

1. Content and Treatment as in Charles K. Chui, An introduction to Wavelets, Academic Press, New York, 1992.

Reference Books

1. Chui C. K. (ed) Approximation theory and Fourier Analysis, Academic Press Boston, 1991.
2. Daribechies. I, Wavelets, CBMS-NSF Series in Appl, SIAM Philadelphia, 1992.
3. Schurnaker, L. L., Spline Functions : Basic Theory, Wiley, New York, 1981.
4. Nurnberger, G, Applications to Spline Functions, Springer Verlag, New York, 1989.

OPERATIONS RESEARCH

Objectives of the Course

- To analyse different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.

UNIT-I

Transportation Models and its Variants: Definition of the Transportation Model – Non-Traditional Transportation Model– Transportation Algorithm – The Assignment Model.

Chapter 5: Sections 5.1, 5.2, 5.3, 5.4. Exercise problems.

UNIT-II

Network Analysis: Network Definitions – Minimal Spanning Tree Algorithm – Shortest Route Problem – Maximum Flow Model – CPM –PERT.

Chapter 6: Sections 6.2, 6.3, 6.4, 6.5, 6.7. Exercise problems.

UNIT-III

Integer Linear Programming: Introduction – Applications –Integer Programming Solutions – Algorithms.

Chapter 9: Sections 9.1, 9.2, 9.3. Exercise problems.

UNIT-IV

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

Chapter 11 – Sections 11.1, 11.2, 11.3, Chapter 16 –Sections 16.1, 16.2, 16.3, Exercise problems.

UNIT-V

Queuing Theory: Basic Elements of Queuing Model – Role of Poisson and Exponential Distributions – Pure Birth and Death Models –Specialised Poisson Queues - (M/G/1): GD/∞/∞)-Pollaczek - Khintechine Formula.

Chapter 17: Sections 17.2, 17.3, 17.4, 17.6, 17.7. Exercise problems.

Recommended Text

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

Reference Books

1. Operations Research, H.K Pathak, Dr. Pradeep K. Joshi and C.Sharma,Shree Shiksha Sahitya Prakashan Publication, Reprint 2022-23.
2. Operations Research: Principles and Applications, Second Edition, G. Srinivasan, Easrern Economy Edition, PHI

NEURAL NETWORKS

Objectives of the Course

- To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications. Acquire in-depth knowledge in Nonlinear dynamics. Apply neural networks to classification and generalization problems.

UNIT-I

Neuron Model and Network Architectures: Mathematical Neural Model-Network Architectures-Perceptron-Hamming Network-Hopfield Network-Learning Rules.

UNIT-II

Perceptron Architectures: Perceptron Architectures and Learning Rules with proof of convergence-Supervised Hebbian Learning-Linear Associator.

UNIT-III

Supervised Hebbian Learning: The Hebb Rule-Pseudo inverse rule-Variation of Hebbian Learning-Back Propagation- Multilayer Perceptrons.

UNIT-IV

Back Propagation: Back Propagation algorithmconvergence and Generalization-Performances surfaces and optimum points-Taylor series.

UNIT-V

Performance surface and performance optimizations: Directional derivatives-Minima-Necessary conditions for optimality- Quadratic functions-Performance optimizations-Steepest Descent Newton's method-Conjugate Gradient.

Recommended Text

1. Martin T. Hagan, Howard B/Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi, 2002.

Reference Books

1. James A.Freeman, David M.Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
2. Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.

Website and e-Learning Source

1. https://nptel.ac.in/courses/117/105/117105084/
2. https://nptel.ac.in/courses/106/106/106106184/

MATHEMATICAL DOCUMENTATION USING LaTex

Objectives of the Course

- To type Mathematical documents in a simple way.

UNIT-I

Introduction - Basics of a Latex file- Text, Symbols and Commands: Command names and arguments – Environments– Declarations – Lengths – Special characters

UNIT-II

Document Layout and Organization: Document class – Page style – Parts of the document – Table of contents

UNIT-III

Displayed Text: Changing font style – Centering and indenting – Lists – Generalized lists Theorem like-declarations

UNIT-IV

Text in Boxes: Boxes - Footnotes and marginal notes. **Tables**: Tabular stops – Tables

UNIT-V

Mathematical Formulas: Mathematical Environment – Main elements of math mode – Mathematical symbols – Additional Elements.

Recommended Text

1. Guide to LaTeX, Helmut Kopka and Patrick W.Daly, Fourth Edition, Addison – Wesley, Pearson Education, 2004.

Reference Books

1. E. Krishnan, LaTeX TUTORIALS — A Primer, Indian TEX Users Group, 2003
2. H. Kopka and P.W. Daly, A Guide to LaTeX, Addison - Wesley, 2003.
3. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011