Master of Science

Mathematics

SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

(Autonomous)

[An Autonomous College Affiliated to Periyar University,Salem,Tamil Nadu]

[Accredited by NAAC with ‘A’ Grade with CGPA of 3.27]

[Recognized 2(f) & 12(B) Status under UGC Act of 1956]

Katteri – 636 902, Uthangarai (Tk), Krishnagiri (Dt)

Tamil Nadu, India

Website: www.svmcugi.com   Email : svm.maths.pg@gmail.com

DEGREE OF MASTER OF SCIENCE IN MATHEMATICS

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS AND SYLLABUS FOR

M.Sc. MATHEMATICS PROGRAMME

(SEMESTER PATTERN)

(For Students Admitted in the College from the Academic Year 2020-2021 Onwards)

Programme Outcomes (POs)

PO1	Identify and enhance mathematical and computational strategies in order to solve mathematical problems.
PO2	Construct logical arguments for solving abstract or applied mathematical problems.
PO3	Obtain accurate solutions for the community oriented problems via various mathematical models.
PO4	Know various specialised areas of advanced mathematics and its applications.
PO5	Present papers in seminars and conferences in order to defend their mathematical skills on various topics in the curriculum.
PO6	Work as professional mathematicians either in academia or elsewhere.
PO7	Inculcate knowledge of formulation and apply mathematical concepts which are suitable for real life applications.
PO8	Crack lectureship and fellowship exams affirmed by UGC like CSIR-NET and SET.

Programme Specific Outcomes (PSOs)

PSO1	Develop the mathematical skills and knowledge for their intrinsic beauty, for proficiency in analytical reasoning, utility in modeling and solving the real world problems by using the concepts of Algebra, Analysis, Dynamics, Differential Equations, Geometry, Topology, Operations Research, Fuzzy Sets & Fuzzy Logic, Fluid Dynamics and Matlab.
PSO2	Develop computational and logical thinking and the habit of making conclusions based on quantitative information.
PSO3	Work efficiently and constructively as a part of a team and do project Individually.
PSO4	Do projects related to emerging Social and Environmental issues.
PSO5	Join in various Universities and Institutions like IMSC, IISc, etc., in order to do summer research projects on Algebra, Analysis, Topology, Mechanics,Fluid Dynamics, Differential Equations, Number Theory, Matlab, Differential Geometry and Fuzzy sets.

SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

(Autonomous)

Master of Science (M.Sc.) in Mathematics

Programme Pattern and Syllabus (CBCS)

(For Students Admitted in the College from the Academic Year 2020-2021 Onwards)

Sl. No.	Nature of the Course	Course Code	Name of the Course	Hours / Week	Credits	Marks		
						CIA	ESE	Total
SEMESTER - I								
1	Core – I	20PMA1C01	Linear Algebra	6	5	25	75	100
2	Core – II	20PMA1C02	Real Analysis – I	6	5	25	75	100
3	Core – III	20PMA1C03	Ordinary Differential Equations	6	4	25	75	100
4	Core – IV	20PMA1C04	Classical Mechanics	6	4	25	75	100
5	Elective – I	----	From Group – A	6	4	25	75	100
Total				**30**	**22**	**125**	**375**	**500**
SEMESTER - II								
6	Core – V	20PMA2C05	Abstract Algebra	6	5	25	75	100
7	Core – VI	20PMA2C06	Real Analysis – II	6	5	25	75	100
8	Core – VII	20PMA2C07	Partial Differential Equations	6	4	25	75	100
9	Core – VIII	20PMA2C08	Graph Theory	6	4	25	75	100
10	Elective – II	----	From Group – B	4	4	25	75	100
11	Common Course	20P2HR01	Human Rights	2	2	25	75	100
Total				**30**	**24**	**150**	**450**	**600**

SEMESTER - III								
12	Core – IX	20PMA3C09	Complex Analysis	6	5	25	75	100
13	Core – X	20PMA3C10	Topology	6	5	25	75	100
14	Core – XI	20PMA3C11	Measure Theory and Integration	6	4	25	75	100
15	Core – XII	20PMA3C12	Calculus of Variation & Integral Equations	6	4	25	75	100
16	Elective – III	----	From Group – C	6	4	25	75	100
Total				**30**	**22**	**125**	**375**	**500**
SEMESTER - IV								
17	Core – XIII	20PMA4C13	Functional Analysis	6	5	25	75	100
18	Core – XIV	20PMA4C14	Probability Theory	6	4	25	75	100
19	Core – XV	20PMA4C15	Optimization Techniques	6	4	25	75	100
20	Elective – IV	----	From Group – D	6	4	25	75	100
21	Core-XVI	20PMA4PR01	Project	6	5	-	100	100
Total				**303**	**22**	**100**	**400**	**500**
Cumulative Total				**120**	**90**	**500**	**1600**	**2100**

Elective Course

Semester	Course Code	Paper Title	Credits
Group – A			
Semester I	20PMA1E01	Numerical Analysis	4
	20PMA1E02	Difference Equations	4
	20PMA1E03	Stochastic Processes	
Group – B			
Semester II	20PMA2E04	Discrete Mathematics	4
	20PMA2E05	Fuzzy Sets and applications	4
	20PMA2E06	Fluid Dynamics	4
Group – C			
Semester III	20PMA3E07	Combinatorial Mathematics	4
	20PMA3E08	Mathematical Statistics – I	4
	20PMA3E09	Fractional Differential Equations	4
Group – D			
Semester IV	20PMA4E10	Number Theory	4
	20PMA4E11	Differential Geometry	4
	20PMA4E12	Mathematical Statistics – II	4

Note:

CBCS – Choice Based Credit system

CIA – Continuous Internal Assessment

ESE – End of Semester Examinations

SWAYAM –Study Webs of Active-Learning for Young Aspiring Minds

NPTEL –National Programme on Technology Enhanced Learning

PROGRAMME SYLLABUS

Program: M.Sc. Mathematics				
Core – I	**Course Code:** 20PMA1C01		**Course Title:** Linear Algebra	
Semester I	**Hours/Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

The objective of this course is to develop a strong foundation in linear algebra that provide a basic for advanced studies not only in mathematics but also in other branches like engineering, physics and computers, etc. Particular attention is given to canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.

Unit I: Linear Transformations

Linear transformations – The Algebra of Linear Transformations-Isomorphism – Representations of linear transformations by matrices – Linear functional. (Chapter 3: Sections: 3.1–3.5, Pages 67–107).

Unit II: Algebra of Polynomials

Algebra-The algebra of polynomials –Polynomial ideals - The prime factorization of a polynomial - Determinant functions. (Chapter 4: Sections: 4.1, 4.2, 4.4 & 4.5, Pages: 117–123 & 127–139) and (Chapter 5: Sections: 5.1 & 5.2, Pages: 140–150).

Unit III: Determinants

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials. (Chapter 5: Sections: 5.3 & 5.4, Pages: 150–162) and (Chapter 6: Sections: 6.1–6.3, Pages: 181–197).

Unit IV: Diagonalization

Invariant subspaces – Simultaneous triangulations – Simultaneous Diagonalization – Direct-sum decompositions – Invariant direct sums – Primary decomposition theorem. (Chapter 6: Sections: 6.4–6.8, Pages: 198–226).

Unit V: The Rational and Jordan Forms Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem - Rational forms – Jordan forms. (Chapter 7: Sections: 7.1–7.3, Pages: 227–251).

Text Book

1. Kenneth M Hoffman and Ray Kunze, “Linear Algebra”, 2nd Edition, Prentice hall of India Pvt. Ltd., New Delhi, 2015.

Reference Books

1. M. Artin, “Algebra”, Prentice hall of India Pvt. Ltd., 2005.
2. S.H. Friedberg, A.J. Insel and L.E Spence, “Linear Algebra”, 4th Edition, Prentice hall of India Pvt. Ltd., 2009.
3. I.N. Herstein, “Topics in Algebra”, 2nd Edition, Wiley Eastern Ltd., New Delhi, 2013.
4. J.J. Rotman, “Advanced Modern Algebra”, 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
5. G. Strang, “Introduction to Linear Algebra”, 2nd Edition, Prentice hall of India Pvt. Ltd., 2013.

E –Learning Source

http://nptel.ac.in/courses/111106051/

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand basic concepts of Linear transformations,characteristic roots and matrices of linear transformation and its applications.	K2
CO2	Explain about algebra of polynomials, polynomial ideals and prime factorization of a polynomial.	K4
CO3	Understand basic concepts of determinents and its additional properties.	K2
CO4	Understand concepts of Simultaneous triangulations and Diagonalization.	K3
CO5	Analyse canonical Form, Jordan Form and Rational Form.	K4 & K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – II	Course Code: 20PMA1C02		Course Title: Real Analysis – I	
Semester	Hours/Week	Total Hours	Credits	Total Marks
I	6	90	5	100

Course Objectives

The course will develop a deeper and more rigorous understanding of calculus including defining terms and proving theorems about functions, sequences, series, limits, continuity and derivatives. The course will develop specialized techniques in problem solving.

Unit I: Basic Topology

Finite, Countable and Uncountable Sets – Metric Spaces – Compact Sets – Connected Sets (Perfect sets - Omitted). (Chapter 2: Pages: 24–40 & 42–46).

Unit II: Numerical Sequences and Series

Convergent sequences – Subsequences – Cauchy sequences - Upper and lower limits - Some special sequences – Series – Series of nonnegative terms - The number *e* - The root and ratio tests. (Chapter 3: Pages: 47–68).

Unit III: Rearrangements of Series

Power series – Summation by parts – Absolute convergence – Addition and multiplication of series – Rearrangements. (Chapter 3: Pages: 69–82).

UNIT IV: Continuity

Limit of Functions – Continuous functions - Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic functions – Infinite limits and Limits at infinity. (Chapter 4: Pages: 83–102).

UNIT V: Differentiation

The derivative of a real function – Mean value theorems – The continuity of the Derivative – L' Hospital's Rule – Derivatives of Higher order – Taylor's theorem – Differentiation of Vector–valued functions. (Chapter 5: Pages: 103–119)

Text Book

1. Walter Rudin, "Principles of Mathematical Analysis", 3rd Edition, McGraw Hill Book Co., Kogaskusha (1976)

Reference Books

1. Tom M. Apostol, "Mathematical Analysis", Narosa Publishers, New Delhi, 2002.

2. R. G. Bartle and D.R. Sherbert, “Introduction to Real Analysis”, John Wiley & Sons, New York, 1982.
3. W.J. Kaczor and M.T. Nowak, “Problems in Mathematical Analysis I – Real Numbers, Sequences and Series”, American Mathematical Society, 2000.
4. W.J. Kaczor and M.T. Nowak, “Problems in Mathematical Analysis II – Continuity and Differentiation”, American Mathematical Society, 2000.
5. Steven G. Krantz, Real Analysis and Foundations, 4th Edition, CRC Press, 2017.
6. H.H.Sohrab, “Basic Real Analysis”, Springer International Edition, India, 2006.

E-Learning Source

https://ocw.mit.edu/courses/mathematics/18-100a-introduction-to analysis-fall-2012.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.	K2
CO2	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.	K2
CO3	Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.	K3
CO4	Describe fundamental properties of the real numbers that lead to the formal development of real analysis.	K5
CO5	Comprehend regions arguments developing the theory underpinning real analysis.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	S	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – III	Course Code: 20PMA1C03		Course Title: Ordinary Differential Equations	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	6	90	4	100

Course Objectives

The objective of this course is to equip the students with knowledge of some advanced concepts related to ordinary differential equations and to understand the concepts related to the solution of ordinary differential equations.

Unit I: Linear Equations with Constant Coefficients

The second order homogeneous equation – Initial value problems for second order equations - Linear dependence and independence – A formula for Wronskian. (Chapter 2: Sections: 1–5, Pages: 49–65).

Unit II: Linear Equations with Constant Coefficients

The non-homogeneous equation of order two – The homogeneous equation of order n – A special method for solving the non-homogeneous equation.

Linear Equations with Variable Coefficients

Reduction of the order of a homogeneous equation – The Legendre Equation. (Chapter 2: Sections: 6, 7 & 11, Pages: 66–75 & 90–93) and (Chapter 3: Sections: 5 & 8, Pages: 118–121 & 130–136).

Unit III: Linear Equations with Regular Singular Points

The Euler equation – Second order equations with regular singular points – The Bessel Equation – The Bessel Equation (continued). (Chapter 4: Sections: 1, 2, 3, 7 & 8, Pages: 143–154 & 168–178).

Unit IV: Existence and Uniqueness of Solutions to First Order Equations

Equations with variables separated – Exact equations – The method of successive approximations – The Lipschitz condition – Convergence of the successive approximations. (Chapter 5: Sections: 1–6, Pages: 185–214).

Unit V: Boundary Value Problems

Sturm-Liouville problem – Green’s functions. (Chapter 7: Sections: 7.1–7.3).

Text Books

1. Earl A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall of India, New Delhi, 2011. (For Unit I to IV).
2. S.G. Deo, V. Lakshmikantham and V. Raghavendra, "Textbook of Ordinary Differential Equations", Tata McGraw-Hill, New Delhi, 1997. (For Unit V).

Reference Books

1. R.P. Agarwal and R. C. Gupta, "Essentials of Ordinary Differential Equation", McGraw Hill, New York, 1991.
2. A.K. Nandakumaran, P.S. Satti, Raju K. George, "Ordinary Differential Equations: Principles and Applications", Cambridge University Press, 2017.
3. D. Rai, D.P. Choudhury and H.I. Freedman, "A Course in Ordinary Differential Equations", Narosa Publ. House, Chennai, 2004.
4. Tyn Myint-U, "Ordinary Differential Equations", Elsevier Science, 1977.
5. Martin Braun, "Differential Equations and Their Applications: An Introduction to Applied Mathematics", Springer, 4th Edition, 1992.

E–Learning Source

http://nptel.ac.in/courses/111104031/ https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Acquire adequate knowledge about linear dependence and independence of the solutions of differential equations based on Wronskian value.	K2
CO2	Solve numerous initial value problems of homogenous and non-homogenous equations of n-th order.	K2
CO3	Gain understanding on the reduction of order of a homogenous equation, nature of the same with analytic coefficients and relate them on a Legendre equation.	K3
CO4	Examine the computations of Euler equations, equations with regular singular points along with the exception – The Bessel equation.	K5
CO5	Conclude the idea of Convergence of the successive approximations employing the Lipschitz condition.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	M	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – IV		**Course Code:** 20PMA1C04	**Course Title:** Classical Mechanics	
Semester I	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To study mechanical systems under generalized coordinate, virtual work, energy and momentum, also to study the mechanics developed by Newton, Lagrange, Hamilton and Jacobi. To develop flexibility and creativity of the students in applying mathematical ideas and techniques to unfamiliar problems arising in everyday life.

Unit I: Introductory Concepts

The mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum. (Chapter 1: Sections: 1.1–1.5).

Unit II: Lagrange's Equation

Derivation of Lagrange's equations – Examples – Integrals of the Motion. (Chapter 2: Sections: 2.1–2.3).

Unit III: Hamilton's Equations

Hamilton's principles – Hamilton's equations – Other variational principles. (Chapter 4: Sections: 4.1–4.3).

Unit IV: Hamilton-Jacobi Theory

Hamilton's Principal Function – The Hamilton-Jacobi equation – Separability. (Chapter 5: Sections: 5.1–5.3).

Unit V: Canonical Transformation

Differential forms and generating functions – Special transformations – Lagranginan and poisson brackets. (Chapter 6: Sections: 6.1–6.3).

Text Book

1. Classical Dynamics, Donald T. Greenwood, PHI Pvt. Ltd., New Delhi, 1985.

Reference Books

1. H. Goldstein, Classical Mechanics (2nd Edition), Narosa Publishing House, New Delhi, Reprint, 2001
2. Narayan Chandra Rana & PromodSharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991

E-Learning Source

https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic concepts of the mechanical system,generalized coordinates, work, energy and momentum	K1&K2
CO2	Solve and analyze the Lagrange's equations and integrals of motion with examples	K3&K4
CO3	Understand the Hamilton's Principle and other variational principles and gain ability to analyze those principles to the problems arising in practical situations	K3
CO4	Gain knowledge about the differential forms and generating functions in canonical transformations, the bilinear covariant and compare the Lagrange's and Poisson brackets	K4&K5
CO5	Understand and develop the Hamilton's Principal function and Hamilton Jacobi equation	K3&K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – I (From Group – A)		**Course Code:** 20PMA1E01	**Course Title:** Numerical Analysis	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	6	90	4	100

Course Objectives

This course aims at providing the necessary basic concepts of numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.

Unit I: Numerical Solutions to Ordinary Differential Equation

Numerical solutions to ordinary differential equation – Power series solution – Pointwise method – Solution by Taylor's series – Taylor's series method for simultaneous first order differential equations – Taylor's series method for Higher order Differential equations – Predictor – Corrector methods – Milne's method – Adam – Bashforth method. (Chapter 11: Sections: 11.1–11.6 & Sections: 11.18–11.20, Pages: 11.3–11.12 & 11.49–11.59).

Unit II: Picard and Euler Methods

Picard's Method of successive approximations – Picard's method for simultaneous first order differential equations – Picard's method for simultaneous second order differential equations – Euler's Method – Improved Euler's method – Modified Euler's Method. (Chapter 11: Sections: 11.7–11.12, Pages: 11.13–11.32).

Unit III: Runge-Kutta Method

Runge's method – Runge-Kutta methods – Higher order Runge-Kutta methods-Runge-Kutta methods for simultaneous first order differential equations – Runge-Kutta methods for simultaneous second order differential equations. (Chapter 11: Sections: 11.13–11.17, Pages: 11.32–11.49).

Unit IV: Numerical Solutions to Partial Differential Equations

Introduction – Difference Quotients – Geometrical representation of partial differential quotients – Classifications of partial differential equations – Elliptic equation – Solution to Laplace's equation by Liebmann's iteration process. (Chapter 12: Sections: 12.1–12.6, Pages: 12.1–12.23).

Unit V: Numerical Solutions to Partial Differential Equations (Contd.)

Poisson equation – Its solution – Parabolic equations – Bender – Schmidt method – Crank – Nicholson method – Hyperbolic equation. (Chapter 12: Sections: 12.7–12.10, Pages: 12.23–12.42).

Text Book

1. V.N. Vedamurthy and Ch. S.N. Iyengar, Numerical Methods, Vikas Publishing House Pvt. Ltd., 1998.

Reference Books

1. S.S. Sastry, Introductory Methods of Numerical Analysis, Printice hall of India, 1995.
2. C.F. Gerald and P.O. Wheathy, Applied Numerical Analysis, Fifth Edition, Addison Wesley, 1998.
3. M.K. Venkatraman, Numerical Methods in Science and Technology, National Publishers Company, 1992.
4. P. Kandasamy, K. Thilagavathy, K. Gunavathy, Numerical Methods, S. Chand & Company, 2003.

E-Learning Sources

http://www.math.ust.hk/~machas/numerical-methods.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand and apply Numerical Solution to ODE.	K2&K3
CO2	Analyze Picards and Eulers Method.	K4
CO3	Evaluate Runge-Kutta Method-First,Second order Differential Equations	K5
CO4	Understand and apply Numerical Solution to PDE	K2&K3
CO5	Analyze Numerical Solution to PDE	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – I (From Group – A)		**Course Code:** 20PMA1E02		**Course Title:** Difference Equations
Semester I	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To introduce the process of discretization, discrete version of Differential Equations, oscillation and the asymptotic behavior of solutions of certain class of difference equations. Solving difference equations using z-transforms is stressed.

Unit I: Difference Calculus

Difference operator – Summation – Generating function – Approximate summation. (Chapter 2, Sections: 2.1–2.3).

Unit II: Linear Difference Equations

First order equations – General results for linear equations. (Chapter 3, Sections: 3.1–3.2).

Unit III: Linear Difference Equations (Contd.)

Equations with constant coefficients – Equations with variable coefficients – z – transform. (Chapter 3, Sections: 3.3, 3.5 & 3.7).

Unit IV: Initial Value Problems for Linear Systems

Initial value problems for linear systems – Stability of linear systems. (Chapter 4, Sections: 4.1–4.3).

Unit V

Asymptotic analysis of sums – Linear equations. (Chapter 5, Sections: 5.1–5.3).

Text Book

1. W.G. Kelley and A.C. Peterson, Difference Equations, Academic press, New York, 1991.

Reference Books

1. S.N. Elaydi, An Introduction to Difference Equations, Springer – Verleg, NewYork, 1990
2. R. Mickens, Difference Equations, Van Nostrand Reinhold, New York, 1990.
3. R.P. Agarwal, Difference Equations and Inequalities Marcel Dekker, New York, 1992.

E–Learning Sources

http://people.math.aau.dk/~matarne/11-imat/notes2011a.pdf

http://pj.freefaculty.org/guides/stat/Math/DifferenceEquations/DifferenceEquationsguide.pdf.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Evoke basic concepts behind the theory of difference oprators	K2
CO2	Interpret notation of solving linear difference equations of first order.	K2
CO3	Perceive idea of converting nonlinear equations into linear and their applications on Z-transform	K3
CO4	Resolve various initial value problem for linear systems	K5
CO5	Appraise methods of Asymptotic and analysis and non linear equations	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	M	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – I (From Group – A)		**Course Code:** 20PMA1E03		**Course Title:** Stochastic Processes
Semester I	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To introduce to the students the basic ideas of Stochastic processes, Markov chains, Markov process and Renewal process and to motivate research in these areas.

Unit I: Stationary Process

Specification of Stochastic processes – Stationary processes – Markov chains – Definitions and Examples – Higher Transition Probabilities – Generalization of Independent Bernoulli trails – Sequence of chain dependent trials. (Chapter 2: Sections: 2.2 & 2.3 and Chapter 3: Sections: 3.1–3.3).

Unit II: Markov Chains

Stability of a Markov system – Graph theoretic approach – Markov chain with denumerable Number of states – Reducible chains – Statistical inference for Markov chains. (Chapter 3: Sections: 3.6–3.10).

Unit III: Markov Processes with Discrete State Space: Poisson Process and its Extensions

Poisson process – Poisson process and related distributions – Generalizations of Poisson process – Birth and death process – Markov process with discrete state space (Continuous time Markov chains). (Chapter 4: Sections: 4.1–4.5).

Unit IV: Markov Processes with Continuous State Space

Brownian motion – Wiener process – Differential equations for a Wiener process Kolmogorov Equations – First Passage time distribution for Wiener process. (Chapter 5: Sections: 5.1–5.5).

Unit V: Renewal Processes and Theory Renewal process – Renewal process in continuous time – Renewal equation – Stopping time: Wald’s equation – Renewal theorems– Delayed and equilibrium renewal processes. (Chapter 6: Sections: 6.1–6.6).

Text Book

1. J. Medhi, Stochastic Processes, Second Edition, New Age International Publication, New Delhi, 2002.

Reference Books

1. Erhan Cinlar, Introduction to Stochastic Process, Prentice Hall Inc., 1975.
2.Samauel Karlin, A First Course in Stochastic Process, Second edition Academic Press 1968.
3. S.K. Srinivasan and A. Vijayakumar, Stochastic Process, Narosa Publishing House, New Delhi, 2003.
4. V. Narauyan Bhat, Elements of Applied Stochastic Processes, John Wiley and Sons, 1972.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand stochastic models for many real life probabilistic situations.	K2
CO2	Learn well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.	K2
CO3	Learn transition probabilities and its classifications.	K3
CO4	Solve random walk associated with real life situation t.	K5
CO5	Evauate the real life queueing problems by comparing the conventional queueing models.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – V	**Course Code:** 20PMA2C05		**Course Title:** Abstract Algebra	
Semester II	**Hours/Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

The objective of this course is to introduce the basic ideas of counting principle, Sylow subgroups, finite abelian groups, field theory and Galois Theory and to see its application to the solvability of polynomial equations by radicals.

Unit I: Sylow's Theorem

Another Counting Principle – 1st, 2nd and 3rd parts of Sylow's Theorems – Double coset – The normalizer of a group. (Chapter 2: Sections: 2.11 & 2.12, Pages: 82–101).

Unit II: Finite Abelian Groups

External and Internal direct Products – Structure theorem for finite abelian groups – Non isomorphic abelian groups – Polynomial rings. (Chapter 2: Sections: 2.13 & 2.14, Pages: 103–115) and (Chapter 3: Section: 3.9, Pages: 153–158).

Unit III: Splitting Field

Polynomials over rational fields – The Eisenstein criterion – Extension fields – Roots of polynomials – Splitting fields. (Chapter 3: Section: 3.10, Pages: 159–161) and (Chapter 5: Sections: 5.1 & 5.3, Pages: 207–214 & 219–227).

Unit IV: Galois Theory

More about roots – Simple extension – Separable extension – Fixed fields – Symmetric rational functions – Normal extension – Galois group – Fundamental theorem of Galois theory. (Chapter 5: Section: 5.5 & 5.6, Pages: 232–249).

Unit V: Solvability by Radicals

Solvable group – The commutator subgroup – Solvability by radicals – Finite fields. (Chapter 5: Section: 5.7, Pages: 250–256) and (Chapter 7: Section: 7.1, Pages: 356–360).

Text Book

1. I.N. Herstein, Topics in Algebra, 2nd Edition, John Wiley and Sons, New York, 1975.

Reference Books

1. S. Lang, "Algebra", 3rd Edition, Addison-Wesley, Mass, 1993.

2. John B. Fraleigh, "A First Course in Abstract Algebra", Addison Wesley, Mass, 1982.
3. M. Artin, "Algebra", Prentice-Hall of India, New Delhi, 1991.
4. V. K. Khanna and S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publishing House Pvt. Limited, 1993.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand Sylows theorem and its applications.	K2
CO2	Acquire knowledge on extension fields and roots of Polynomials.	K2
CO3	Analyze elements of Galois theory and Galois Groups over the Rationals.	K3
CO4	Explain Wedderburn's Theorem on Finite Division Rings and a theorem of Frobenius.	K5
CO5	Analysis finite field and solvability by radicals.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	S	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	S	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – VI		**Course Code:** 20PMA2C06		**Course Title:** Real Analysis – II
Semester II	**Hours/Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

The course will develop a deeper and more rigorous understanding of calculus including defining terms and proving theorems about sequence and series of functions, integration, special functions and multivariable calculus. The course will develop specialized techniques in problem solving.

Unit I: Riemann – Stieltjes Integral

Definition and Existence of the Integral – Properties of the Integral – Integration and Differentiation – Integration of Vector-valued functions – Rectifiable curves. (Chapter 6: Pages: 120–137).

Unit II: Sequences and Series of Functions

Discussion of main problem – Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration – Uniform Convergence and Differentiation.(Chapter 7: Pages: 143–154).

Unit III: Sequences and Series of Functions (Contd…)

Equicontinuous families of functions – Stone-Weierstrass Theorems – Algebra of complex valued functions. (Chapter 7: Pages: 155–171).

Unit IV: Some Special Functions

Power series – The Exponential and Logarithmic functions – Trigonometric Functions – Fourier series - The Gamma functions (Algebraic completeness of the complex field - omitted). (Chapter 8: Pages: 172–203, Omit Theorem 8.8).

Unit V: Functions of Several Variables

Linear transformations – Differentiation – The contraction principle - The inverse function theorem – The implicit function theorem. (Chapter 9: Pages: 204–228).

Text Book

1. Walter Rudin, "Principles of Mathematical Analysis", 3rd Edition, McGraw Hill Book Co., Kogaskusha, 1976.

Reference Books

1. T.M. Apostol, “Mathematical Analysis”, Narosa Publishers, New Delhi, 1985.
2. W.J. Kaczor and M.T. Nowak, “Problems in Mathematical Analysis III – Integration”, American Mathematical Society, 2000.
3. A. Browder, “Mathematical Analysis, an Introduction”, Springer-Verlag, New York, 1996.
4. K.A. Ross, “Elementary Analysis: The Theory of Calculus”, 2nd Edition, Springer, New York, 2013.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand Riemann integrals and its properties.	K2
CO2	Acquire knowledge for any advanced learning in Pure Mathematics.	K2
CO3	Solve Convergence of a sequences and series of functions.	K3
CO4	Evaluate the basics of special functions.	K5
CO5	Analyse Multivariate analysis.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	S	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics		
Core – VII	**Course Code:** 20PMA2C07	**Course Title:** Partial Differential Equations

Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	90	4	100

Course Objectives

The objective of this course is to enable the students to understand the concepts related to the solution of partial differential equations arising in various fields.

Unit I: Partial Differential Equations of First Order

Nonlinear partial differential equations of the first order – Cauchy's method of characteristics – Compatible systems of first order equations – Charpit's method – Special types of first order equations – Jacobi's method. (Chapter 2: Sections: 7– 11 & 13, Pages: 59– 73 & 78–80).

Unit II: Partial Differential Equations of Second Order

Linear partial differential equations with constant coefficients – Equations with variable coefficients – The solution of linear hyperbolic equations – Separation of variables – Nonlinear equations of the second order. (Chapter 3: Sections: 4, 5,8, 9 & 11, Pages: 96– 109, 119– 126 & 131–135).

Unit III: Laplace's Equation

Elementary solution of Laplace's equation – Families of equipotential surfaces – Boundary value problems – Separation of variables – The theory of Green's function for Laplace equation. (Chapter 4: Sections: 2– 5 & 8, Pages: 145– 161 & 167– 174).

Unit IV: The Wave Equation

Elementary solutions of the one-dimensional wave equation – Vibrating membranes: Applications of the calculus of variations – Three dimensional problems – Green's function for the wave equation. (Chapter 5: Sections: 2,4,5 & 7, Pages: 215– 221, 226– 239 & 244–248).

Unit V: The Diffusion Equation

Elementary solutions of the diffusion equation – Separation of variables – The use of Green's functions. (Chapter 6: Sections: 3,4 & 6, Pages: 282– 290 & 294–298).

Text Book

1. I.N. Sneddon, Elements of Partial Differential Equations, Dover, Singapore, 2006.

Reference Books

1. D. Colton, "Partial Differential Equations: An Introduction", Dover Publishers, New York, 1988.
2. H. Hattori, "Partial Differential Equations: Methods, Applications and Theories", World Scientific, Singapore, 2013.
3. M.D. Raisinghania, "Advanced Differential Equations", S. Chand & Company, New Delhi, 2013.
4. K. Sankara Rao, "Introduction to Partial Differential Equations", Second Edition, Prentice –Hall of India, New Delhi, 2006.

E–Learning Sources

https://ocw.mit.edu/courses/mathematics/18-156-differential-analysis-ii-partial-differential-equations-and-fourier-analysis spring2016/index.htm?utm_source=OCWDept&utm_medium=CarouselSm&utm_campaign= Featured Course

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand fundamental concepts of classification of second order partial differential equations, canonical forms.	K2
CO2	Analyse hyperbolic equations.	K2
CO3	Determine the occurence of Laplace equations, boundary value problems and develop Green's function for Laplace Equation.	K3
CO4	Develop the knowledge of one dimensional wave equation.	K5
CO5	Determine the occurence of Diffusion equations,Seperation of Variables and develop Green's function for Laplace Equation.	K3&K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – VIII	**Course Code:** 20PMA2C08		**Course Title:** Graph Theory	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	90	4	100

Course Objectives

To understand the concept of graphs, sub graphs, trees, connectivity, Euler tour, Hamilton cycle, matching, colouring of graphs, independent set, cliques, vertex colouring and planar graphs.

Unit I: Basic Results

Introduction – Basic concepts – Subgraphs – Degrees of vertices – Paths and connectedness – Automorphism of a simple graph. (Chapter 1: Sections: 1.1–1.6). Directed Graphs: Introduction – Basic concepts – Tournaments. (Chapter 2: Sections: 2.1–2.3).

Unit II: Connectivity and Trees

Connectivity: Introduction – Vertex cut and edge cut – Connectivity and Edge Connectivity. (Chapter 3: Sections: 3.1–3.3). **Trees:** Introduction – Definition, characterization and simple properties – Centers and centroids – Cutting the number of spanning trees. (Chapter 4: Sections: 4.1–4.4).

Unit III: Independent Sets and Matchings

Independent Sets and Matchings: Introduction – Vertex – Independent sets and vertex coverings – Edge – Independent sets – Matchings and factors – Matchings in bipartite graphs. (Chapter 5: Sections: 5.1–5.5).

Unit IV: Graph Colorings

Introduction – Vertex colorings – Critical graphs – Edge colorings of graphs – Kirkman's school girl – Problem – Chromatic Polynomials. (Chapter 7: Sections: 7.1, 7.2, (7.2.1 & 7.2.3 only), 7.6, 7.8 & 7.9).

Unit V: Planarity

Introduction – Planar and nonplanar graphs –Euler formula and its consequences – K_5 and $K_{3,3}$ are nonplanar graphs – Dual of a plane graph – The four-color theorem and the heawood five – Color theorem – Hamiltonian plane graphs. (Chapter 8: Sections: 8.1–8.6 & 8.8).

Text Book

1. R. Balakrishnan and K. Ranganathan, Text Book of Graph Theory (2nd Edition), Springer, New York, 2012.

Reference Books

1. J.A. Bondy and U.S.R. Murty, Graph Theory with Applications, North Holland, New York, 1982.
2. Narasing Deo, Graph Theory with Application to Engineering and Computer Science, Prentice Hall of India, New Delhi, 2003.
3. F. Harary, Graph Theory, Addison–Wesely Publication Company, the Mass, 1969.
4. L.R. Foulds, Graph Theory Application, Narosa Publication House, Chennai, 1933.

E–Learning Source

http://cs.bme.hu/fcs/graphtheory.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Know basic definitions and concepts of graphs and subgraphs.	K2
CO2	Getting acquainted with the concepts of trees and connectivity study its applications.	K2
CO3	Recoganize concepts and properties of Euler Tours and Matchings and study its applications.	K3
CO4	Assimilate knowledge about many different coloring problems for graphs, formulate applied problems as coloring problems and understand the notations of independent sets.	K5
CO5	Evaluate applications of graph theory in other disciplines.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – II (From Group – B)		**Course Code:** 20PMA2E04	**Course Title:** Discrete Mathematics	
Semester II	**Hours/Week** 4	**Total Hours** 60	**Credits** 4	**Total Marks** 100

Course Objectives

The objective of this course is to understand the basic ideas of logic, proof methods and strategy, the growth of functions, counting techniques, pigeonhole principle, recurrence relations, solving recurrences using generating functions, Boolean functions, apply Boolean algebra to circuits and gatting networks, use finite state-machines to model computer operations.

Unit I: The Foundation of logic logic – Propositional equivalence – Predicates and quantifiers – Proof methods and strategy – The growth of functions. (Chapter 1: Sections: 1.1–1.3 & 1.8 and Chapter 3: Section: 3.2).

Unit II: Counting – Basics of counting – The pigeonhole principle – Permutations and combinations – Generalized permutations and combinations – Generating permutations and combinations. (Chapter 5: Sections: 5.1–5.3, 5.5 & 5.6).

Unit III: Advanced counting techniques – Recurrence relation – Solving recurrence relations – Generating functions. (Chapter 6: Sections: 6.1, 6.2 & 6.4).

Unit IV: Boolean algebra – Boolean functions – Representing Boolean functions – Logic gates – Minimization of circuits. (Chapter 10: Sections: 10.1–10.4).

Unit V: Modeling computations finite – State machines with output, finite – State machines with no output – Turing machines. (Chapter 12: Sections: 12.2, 12.3 & 12.5).

Text Book

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, 7th Edition, WCB/ McGraw Hill Publications, New Delhi, 2011.

Reference Books

1. Edward A. Bender and S. Gill Williamson, "A Short Course in Discrete Mathematics", Dover Publications, 2006
2. M.O. Albertson and J.P. Hutchinson, "Discrete Mathematics with Algorithms", John Wiley & Sons, 2008.

3. Rajendra Akerkar and Rupali Akarkar, “Discrete Mathematics”, Pearson Education Pvt. Ltd., Singapore, 2004.
4. J.P. Trembley and R. Manohar, “Discrete Mathematical Structures”, Tata McGraw Hill, New Delhi, 1997.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Express a logic sentence in terms of predicates, quantifiers and logical connectives.	K2
CO2	Apply rules of inference and methods of proof including direct and indirect proof forms, proof by contradiction and mathematical induction.	K2
CO3	Solve discrete mathematics problems that involve: computing permutations and combinations of a set, fundamental enumeration principles.	K3
CO4	Evaluate Boolean functions and simplify expressions using the properties of Booleanalgebra.	K5
CO5	Analyze State Machine with output,finite state machine	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	S	M	S	S	S	S
CO4	M	M	S	M	S	S	S	S
CO5	M	M	S	M	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – II (From Group – B)	**Course Code:** 20PMA2E05		**Course Title:** Fuzzy Sets and Applications	
Semester II	**Hours/Week** 4	**Total Hours** 60	**Credits** 4	**Total Marks** 100

Course Objectives

This course aims to introduce fuzzy graphs, fuzzy relations, fuzzy logic and fuzzy composition and initiate the learners into the application of these ideas.

Unit I: Basics

Crispsets – Fuzzy sets: Basic types – Basic concepts – Additional properties of α-cuts – Representation of Fuzzy sets – Extension principle for Fuzzy sets. (Chapter 1: Sections: 1.2–1.4 and Chapter 2: Sections: 2.1–2.3).

Unit II: Operations on Fuzzy sets

Types of operations – Fuzzy complements – Fuzzy intersections: t-norms – Fuzzy unions: t-Conorms – Combinations of operations. (Chapter 3: Sections: 3.1–3.5).

Unit III: Fuzzy Arithmetic

Fuzzy numbers – Linguistic variables – Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers – Lattice of Fuzzy numbers – Fuzzy equations. (Chapter 4: Sections: 4.1–4.6).

Unit IV: Fuzzy Relations

Crisp versus Fuzzy relations – Binary Fuzzy relations – Binary relations on a single set – Fuzzy Equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations – Sup –ω icompositions of Fuzzy relations – Inf -ωicompositions of Fuzzy relations. (Chapter 5: Sections: 5.1, 5.3–5.7, 5.9 & 5.10).

Unit V: Constructing Fuzzy Sets

Methods of construction: An overview – Direct methods with one expert – Direct methods with multiple experts – Indirect methods with one expert - Indirect methods with multiple experts (Chapter 10: Sections: 10.2–10.7).

Text Book

1. George J. Klirand Yuan. B, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall India Private Ltd., 2007.

Reference Books

1. H. J. Zimmerman, Fuzzy Set Theory and its Applications, Second edition Kluwer Academic Publishers, London, 1996.
2. Pundir and Pundir, Fuzzy sets and their Applications, A Pragati Edition, 2006.
3. Timothy J. Ross, Fuzzy logic with engineering Applications, McGraw Hill Inc., New Delhi, 2004.
4. V. Novak, Fuzzy Sets and their Applications, Adam Hilger, Bristol, 1969.

E–Learning Source

http://nptel.ac.in/courses/105108081/module9/lecture36/lecture.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Gain knowledge about basic types of fuzzy sets and difference between crisp sets and fuzzy sets.	K1
CO2	Understand the concept of operations on fuzzy sets.	K2
CO3	Acquire knowledge about concepts of fuzzy arithmetic and gain knowledge to solve the related problems.	K3&K4
CO4	Discriminate relations and fuzzy relations.	K4
CO5	Create a fuzzy model and solve social, environmental and biological problems.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – II (From Group – B)		**Course Code:** 20PMA2E06	**Course Title:** Fluid Dynamics	
Semester II	**Hours/Week** 4	**Total Hours** 60	**Credits** 4	**Total Marks** 100

Course Objectives

This course aims to provide basic knowledge in Kinematics of fluids in motion, equations of motion of a fluid, three dimensional flows and viscous flows.

Unit I: Kinematics of Fluids in Motion

Real fluids and ideal fluids – Velocity of a fluid at a point – Stream lines and path lines – Steady and unsteady flows – The velocity potential – The vorticity vector – Local and particle rates of change – The equation of continuity – Worked examples. (Chapter 2: Sections: 2.1– 2.8).

Unit II: Equations of Motion of a Fluid

Pressure at a point in a fluid at rest – Pressure at a point in a moving fluid – Conditions at a boundary of two inviscid immiscible fluids – Euler's equations of motion – Bernoulli's equation – Worked examples – Discussion of the case of steady motion under conservative body forces. (Chapters 3: Sections: 3.1–3.7).

Unit III: Some Three-Dimensional Flows

Introduction - Sources, Sinks and doublets – Images in rigid infinite plane – Images in solid spheres – Axis symmetric flows. (Chapter 4: Sections– 4.1–4.4).

Unit IV: Some Two-Dimensional Flows

Meaning of two-dimensional flow – Use of cylindrical polar coordinates – The stream function – The complex velocity potential for two dimensional irrotational – Incompressible flow – Complex velocity potentials for standard two-dimensional flows – Some worked examples – Two dimensional image systems – Thomson circle theorem. (Chapter 5: Sections: 5.1–5.8).

Unit V: Viscous Fluid

Stress components in a real fluid – Relation between Cartesian components of stress – Translational motion of fluid element – The rate of strain quadric and principal stresses – Some further properties of the rate of strain quadric – Stress analysis in fluid motion – Relations between stress and rate of strain – The coefficient of viscosity and laminar flow –

The Navier – Stokes equation of a viscous fluid – Some solvable problems in viscous flow – Steady motion between parallel planes only. (Chapter 8: Sections: 8.1 & 8.10.1).

Text Book

1. Frank Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2004.

Reference Books

1. L.M. Milne-Thomson, Theoretical Hydrodynamics, Macmillan, London, 1955.
2. G.K. Batchelor, An Introduction to Fluid Dynamics Cambridge Mathematical Library, 2000.

E–Learning Source

http://web.mit.edu/1.63/www/lecnote.html

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Gain knowledge about real fluids, equations of continuity and vorticity vector.	K2
CO2	Understand notions of fluid pressure and derive Euler's equations of motion.	K2
CO3	Know and apply the concepts of sources, sinks and doublets	K3
CO4	Examine force and moment of the given flow of incompressible fluid using theorem of Blasins.	K5
CO5	Evaluate pressure of a viscous fluid by using Navier-Stokes equations of motion of a viscous fluid and create a fluid dynamics model and solve the problems in Physics, Biology and Engineerin.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – IX		**Course Code:** 20PMA3C09		**Course Title:** Complex Analysis
Semester III	**Hours/Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

To study the Maximum Principle, Schwarz Lemma, Evaluation of Certain Integrals, Analytic Continuation, Representation of Meromorphic and Entire Functions and Mapping Theorems.

Unit I: Maximum Principle, Schwarz' Lemma and Liouville's Theorem

Maximum modulus principle – Hadamard's three circles/lines theorems – Schwarz's Lemma and its consequences – Liouville's theorem - Doubly periodic entire functions – Fundamental theorem of algebra – Zeros of certain Polynomials. (Chapter 6: Sections: 6.1–6.7, Pages: 231–260).

Unit II: Evaluation of Certain Integrals

Integrals of three types – Singularities on the real axis – Integrals involving branch points – Estimation of sums. (Chapter 9: Sections: 9.1–9.6, Pages: 315–345).

Unit III: Analytic Continuation

Direct analytic continuation – Monodromy theorem – Poisson integral formula – Analytic continuation via reflection. (Chapter 10: Sections: 10.1–10.4, Pages: 347–371).

Unit IV: Representation for Meromorphic and Entire Functions

Infinite sums and meromorphic functions – Infinite product of complex numbers – Infinite products of analytic functions – Factorization of entire functions – The Gamma function – The Zeta function – Jensen's formula – The order and the genus of entire functions. (Chapter 11: Sections: 11.1–11.8, Pages: 373–425).

Unit V: Mapping Theorems

Open mapping theorem and Hurwitz' theorem – Basic results on univalent functions – Normal families – The Riemann mapping theorem – Bieberbach conjecture – The Bloch – Landau theorems – Picard's theorem. (Chapter 12: Sections: 12.1–12.7, Pages: 429–461).

Text Book

1. S. Ponnusamy, Foundations of Complex Analysis, Second Edition, Narosa Publishing House, New Delhi, 2015.

Reference Books

1. B. Choudhary, The Elements of Complex Analysis, Second edition, Wiley Eastern Limited, 1992.

2. Boston, Complex Variables, Silverman- Houghton Mifflin Company, 1975.

3. John B. Conway, Functions of One Complex Variable, 2-e, Springer International student Edition, 1973.

4. Serge Lang, Complex Analysis, second edition,Springer-Verlag, New York, 1993.

E–Learning Sources

https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-fall-2003/

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the concepts of maximum principle.	K2
CO2	Evaluation of integrals and singularities.	K2
CO3	Discuss and analyse of analytic continuation.	K3
CO4	Evaluate meromorphic and entire function.	K5
CO5	Discuss open mapping, Riemann mapping and Picard's theorem.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – X	**Course Code:** 20PMA3C10		**Course Title:** Topology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	6	90	5	100

Course Objectives

To develop student's topological and proof writing skills which are essential in the study of advanced mathematics, understand the concepts of topological spaces analyze and synthesize proofs, understanding the concepts of connectedness and compactness.

Unit I: Topological Spaces

Topological spaces – Basis for a topology – The order topology – The product topology on XxY – The subspace topology – Closed sets and limit points. (Chapter 2: Sections: 12–17, Pages: 75–100).

Unit II: Continuous Functions

Continuous Functions – The product topology – The metric topology – The metric topology (continued). (Chapter 2: Sections: 18–21, Pages: 102–133).

Unit III: Connectedness

Connected spaces – Connected subspaces of the real line – Components and local connectedness. (Chapter 3: Sections: 23–25, Pages: 147–162).

Unit IV: Compactness

Compact spaces – Compact subspaces of the real line – Limit point compactness – Local compactness. (Chapter 3: Sections: 26–29, Pages: 163–185).

Unit V: Countability and Separation Axioms

The countability axioms – The separation axioms – Normal spaces – Urysohn Lemma – The Urysohn Metrization theorem – The Tietze extension theorem. (Chapter 4: Sections: 30–35, Pages: 189–222).

Text Book

1. James R. Munkres – Topology, 2nd Edition, Prentice Hall of India Ltd., New Delhi, 2005.

Reference Books

1. J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York, 1963

E–Learning Source

https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Obtain the basic knowledge in topology.	K2
CO2	Understand concepts of continuous functions and construct the topology by using the metric.	K2
CO3	Examine connectedness of topological space.	K3
CO4	Demonstrate fundamental outcomes about compactness within topological structures.	K5
CO5	Characterize; categorize and compare separation axioms and create a model and solve biological problems.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – XI	**Course Code:** 20PMA3C11		**Course Title:** Measure Theory and Integrations	
Semester III	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

1.To acquire knowledge about the concept of Measurable sets and its functions.

2. To know about the concept of Lebesgue integral.

3. To understand the concept Outer measure.

Unit I: Lebesgue Measure

Lebesgue Measure – Introduction – Outer measure – Measurable sets and Lebesguemeasure – Measurable functions – Little Woods' three principles. (Chapter 3: Sections: 1–3, 5 & 6, Pages: 54–63 & 66–73).

Unit II: Lebesgue integral

Lebesgue integral – The Riemann integral – Lebesgue integral of bounded functionsover a set of finite measure – The integral of a nonnegative function – The general Lebesgue integral. (Chapter 4: Sections: 1–4, Pages: 75–93).

Unit III: Differentiation and Integration

Differentiation and Integration – Differentiation of monotone functions – Functions ofbounded variation – Differentiation of an integral – Absolute continuity. (Chapter 5: Sections: 1–4, Pages: 97–110).

Unit IV: General Measure and Integration

General Measure and Integration – Measure spaces – Measurable functions – Integration – Signed measure – The Radon – Nikodym theorem. (Chapter 11: Sections: 1–3, 5 & 6, Pages: 253–267 & 270–279).

Unit V: Measure and Outer Measure

Measure and outer measure – outer measure and measurability – The extension theorem – Product measures. (Chapter 12: Sections: 1, 2 & 4, Pages: 288–298 & 303–310).

Text Book

1. H.L. Royden, Real Analysis, McMillian Publication Co, New York, 1993.

Reference Books

1. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., 1981.

2. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age Int. (P) Ltd., New Delhi, 2000.
3. Walter Rudin, Real and Complex Analysis, Tata McGraw Hill Publ. Co. Ltd., New Delhi, 1966.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the concept of integration using measures.	K2
CO2	Develop the concept of analysis in abstract situations.	K2
CO3	Understand the concepts of measurable function.	K3
CO4	Advance concepts in measure theory.	K5
CO5	Knowledge of decomposition theorems and absolute continuity	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – XII		**Course Code:** 20PMA3C12	**Course Title:** Calculus of Variation and Integral Equations	
Semester III	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

The aim of the course is to introduce to the students the concept of calculus of variation and its applications and to introduce various types of integral equations and how to solve these equations

Unit I: Variational Problems with Fixed Boundaries

The concept of variation and its properties – Euler's equation- Variational problems for Functionals – Functionals dependent on higher order derivatives – Functions of several independent variables – Some applications to problems of Mechanics. (Chapter 1: Sections: 1.1–1.5 & 1.7, Pages: 4–25 & 27–30).

Unit II: Variational Problems with Moving Boundaries

Movable boundary for a functional dependent on two functions – One-side variations – Reflection and refraction of extermals – Diffraction of light rays. (Chapter 2: Sections: 2.1–2.5, Pages: 51–63).

Unit III: Integral Equation

Introduction – Types of Kernels – Eigen values and Eigen functions – Connection with differential equation – Solution of an integral equation – Initial value problems – Boundary value problems. (Chapter 1: Section: 1.1–1.3 & 1.5–1.8 Pages: 1–6 & 8–42).

Unit IV: Solution of Fredholm Integral Equation

Second kind with separable kernel – Orthogonality and reality eigen function – Fredholm Integral equation with separable kernel – Solution of Fredholm integral equation by successive substitution – Successive approximation – Volterra Integral equation – Solution by successive substitution. (Chapter 2: Sections: 2.1–2.3, Pages: 47–96) and (Chapter 4: Sections: 4.1–4.4, Pages: 157–183).

Unit V: Hilbert–Schmidt Theory

Complex Hilbert space – Orthogonal system of functions – Gram Schmitorthogonlization process – Hilbert – Schmit theorems – Solutions of Fredholm integral equation of first kind. (Chapter 3: Section: 3.1-3.4, 3.8 & 3.9, Pages: 99–106 & 117-124).

Text Books

1. A.S Gupta, Calculus of Variations with Application, Prentice Hall of India, New Delhi, 2005. (For Units I and II)
2. Sudir K. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut, 2005. (For Units III, IV and V)

Reference Books

1. F.B. Hildebrand, Methods of Applied Mathematics, Prentice hall of India Pvt, New Delhi, 1968.
2. R.P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York, 1971.

E–Learning Source

http://www.maths.ed.ac.uk/~jmf/Teaching/Lectures/CoV.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the concept of varaiation and its properties.	K2
CO2	Acquire a comprehension on Hamilton'sprinciple, Lagrange's Equation.	K2
CO3	Understand the basic concepts of integral equations.	K3
CO4	Implement various problems on differential and integral equations with special reference to Fredholm equations.	K5
CO5	Resolve the utilisation of Hilbert-schmidt theory.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – III (From Group – C)		**Course Code:** 20PMA3E07	**Course Title:** Combinatorial Mathematics	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	6	90	4	100

Course Objectives

The aim of the course is to introduce to the students the concept of Perumation and Combinatorics and to introduce Generating function , recuurnce relation .

Unit I: Permutations and Combinatorics

The Rules of sum and product – Permutations – Combinations – Distributions of distinct objects –Distribution of nondistinct objects – Stirling's formula.

Unit II: Generating Functions

Generating functions for combinations – Enumerators for permutations- Distributions of distinct objects into nondistinct cells – Partitions of integers – The Ferrers graph – Elementary relations.

Unit III: Recurrence Relations

Linear recurrence relations with constant coefficients – Solution by the technique of generating functions – A special class of nonlinear difference equations – Recurrence relations with two indices.

Unit IV: The Principle of Inclusion and Exclusion

The Principle of inclusion and exclusion – The general formula – Derangements – Permutations with restrictions on relative positions – The rook polynomials – Permutations with forbidden positions.

Unit V: Polya's Theory of Counting

Sets, relations and groups – Equivalence classes under a permutation group – Equivalence classes of functions – Polya's fundamental theorem – Generalization of Polya's theorem.

Text Book

1. C.L. Liu, "Introduction to Combinatorial Mathematics", McGraw Hill Book Company, New York, 1968.

Reference Books

1. Murray Edelberg and C. L. Liu, "Solutions to Problems in Introduction to Combinatorial Mathematics", MC Grow-Hill Book & Co., New York, 1968.

2. R.P. Stanley, “Enumerative Combinatorics”, Volume I, 2nd Edition, Cambridge Studies in Advanced Mathematics, Cambridge University Press, 1997.
3. P.J. Cameron, “Combinatorics: Topics, Techniques, Algorithms”, Cambridge University Press, Cambridge, 1998.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the concepts of permutation and combination.	K2
CO2	Analyse the distribution of distinct objects.	K2
CO3	Examine recurrence relations.	K3
CO4	Understand the concepts of principle of inclusion and exclution.	K5
CO5	Analyse of Poly’s fundamental theorem.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – III (From Group – C)		**Course Code:** 20PMA3E08		**Course Title:** Mathematical Statistics – I
Semester III	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To learn the concepts of Mathematical Statistics. To understand the occurrence of probability models. To create consciousness of applications of Mathematical Statistics.

Unit I: Probability

Basic terminology – Mathematical probability – Axiomatic approach to probability – Theorems on probability – Conditional probability - Independent events – Pair wise independent events. (Chapter 3: Sections: 3.3, 3.4, 3.8–3.15).

Unit II: Random Variables and Distribution Functions

Introduction – Distribution functions – Discrete random variables – Continuous random variable – Two dimensional random variables. (Chapter 5: Sections: 5.1–5.5; Omit: 5.4.1, 5.4.2, 5.5.6 & 5.5.7).

Unit III: Mathematical Expectation and Generating Functions

Introduction – Mathematical expectation – Expected values of function of a random variable – Properties of expectation – Properties of variance – Covariance – Inequalities involving expectations – Moment generation function – Cumulants – Characteristic function – Chebychev"s inequality – Bernoulli law of large numbers. (Chapter 6: Sections: 6.1–6.7 and Chapter 7: Sections: 7.3, 7.5 & 7.7.1).

Unit IV: Discrete and Continuous Distributions

Bernoulli distribution – Binomial distribution – Poisson distribution – Normal distribution – Rectangular distribution – Gamma distribution. (Chapter 8: Sections: 8.3–8.5 and Chapter 9: Sections: 9.2, 9.3 & 9.5; Omit: 9.2.12 & 9.2.15).

Unit V: Correlation and Regression

Meaning of correlation – Scatter diagram –Karl Pearson"s correlation coefficient – Bivariate frequency distribution – Probable error – Rank correlation – Linear regression. (Chapter 10: Sections: 10.2–10.7 and Chapter 11: Sections: 11.1 & 11.2).

Text Book

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th edition Sultan Chand & Sons, New Delhi, 2009.

Reference Books

1. Murray R. Spiegel, Statistics,Second edition McGraw Hill Book Company, New Delhi, 1992.
2. Richard A. Janson, Miller, Freunds, Probability and Statistics for Engineers, 6th edition Pearson Education Pvt. Ltd., Delhi, 2001.
3. Sheldon Ross, A First Course in Probability, 6th edition Pearson Education Pvt. Ltd., Delhi, 2014.
4. William – Feller, An Introduction to Probability Theory and its Applications,3rd edition Wiley Eastern Limited, New Delhi, 1968.

E–Learning Source

http://mathword.wolfram.com

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understanding basic concepts of probability.	K2
CO2	Gain knowledge about random variables and distribution functions.	K2
CO3	Understanding the concepts of mathematical expections.	K3
CO4	Analyse about the one-point, two-point distributions, Binomial distribution, Poisson distribution and Normal distribution.	K5
CO5	Evaluaion of correlation and regression.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	M	M	S	S	S	S
CO5	M	M	M	M	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – III (From Group – C)	**Course Code:** 20PMA3E09		**Course Title:** Fractional Differential Equations	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	6	90	4	100

Course Objectives

The aim of course is to learn the concept of Fractional Derivatives and Analyze the property of Fractional Derivatives

Unit I: Grunwald-Letnikov Fractional Derivatives

Unification of integer-order derivatives and integrals – Integrals of arbitrary order – Derivatives of arbitrary order – Fractional derivative of (t – a)^β - Composition with integer order derivatives – Composition with fractional derivatives.

Unit-II: Riemann – Liouville Fractional Derivatives

Unification of integer-order derivatives and integrals – Integrals of arbitrary order – Derivatives of arbitrary order – Fractional derivative of (t – a)^β - Composition with integer order derivatives – Composition with fractional derivatives – Link to the Grunwald – Letnikov Approach.

Unit-III: Properties of Fractional Derivatives

Linearity – The Leibniz rule for fractional derivatives – Fractional derivative of a composite function – Riemann–Liouville fractional differentiation of an integral depending on a parameter – Behaviour near the lower terminal – Behaviour far from the lower terminal. Caputo's fractional derivative – Generalized functions approach – Sequential fractional derivatives – Left and right fractional.

Unit-IV: Some other Approaches and Laplace Transforms of Fractional Derivatives

Derivatives – Basic facts on the Laplace transform - Laplace transform of the Riemann – Liouville fractional derivative – Laplace transform of the Caputo derivative – Laplace transform of the Grunwald – Letnikov fractional derivative – Laplace transform of the Miller – Ross sequential fractional derivative.

Unit V: Existence and Uniqueness Theorems

Linear fractional differential equations – Fractional differential equations of a general form – Existence and uniqueness theorem as a method of solution – Dependence of a solution on initial conditions.

Text Book

1. I. Podlubny, Fractional Differential Equations, Academic Press, London, 1999.\

Reference Books

1. K.S. Miller and B. Ross, An Introduction to the Fractional Calculus and Fractional Differential Equations, John Wiley & Sons, New York, 1993.
2. A.A. Kilbas, H.M. Srivastava and J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, 2006.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the concepts of fractional derivative,integer order derivative and integrals	K1&K2
CO2	Apply the concept of fractional derivative in Liouville fractional derivatives	K3
CO3	Analyze the property of fractional derivative	K4
CO4	Analyze the Laplace transform in various derivative	K4
CO5	Evaluate the Existence and uniqueness theorems	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – XIII		**Course Code:** 20PMA4C13		**Course Title:** Functional Analysis
Semester IV	**Hours/Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

To provide students with a strong foundation in functional analysis,focusing on spaces, operators and fundamental theorems. To develop student's skillsand confidence in mathematical analysis and proof techniques.

Unit I: Banach Spaces

Banach Spaces – The Definition and Some examples – Continuous linear transformations – Hahn Banach theorem. (Chapter 9: Sections: 46–48, Pages: 211–229).

Unit II: Banach Spaces and Hilbert Spaces

The natural embedding of N in N** – Open mapping theorem – Conjugate of an operator – Hilbert space – Definition and some Simple properties. (Chapter 9: Sections: 49–51, Pages: 231–242 and Chapter 10: Section: 52, Pages: 244–248).

Unit III: Hilbert Spaces

Orthogonal complements – Orthonormal sets – Conjugate space H* - Adjoint of an operator. (Chapter 10: Sections: 53–56, Pages: 249–265).

Unit IV: Operations on Hilbert Spaces

Self adjoint operator – Normal and Unitary operators – Projections. (Chapter 10: Sections: 57–59, Pages: 266–276).

Unit V: Banach Algebras

Banach Algebras – Definition and examples – Regular and simple elements – Topological divisors of zero – Spectrum – The formula for the spectral radius – The radical and semi simplicity. (Chapter 12: Sections: 64–69, Pages: 302–317).

Text Book

1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Inter. Book Co., New York, 1963.

References

1. W. Rudin, Functional Analysis, Tata McGraw Hill publication Co., New Delhi, 1973.

2. H.C. Goffman and G.Fedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.

3. D. Somasundaram, Functional Analysis S. Viswanathan Pvt. Ltd., Chennai, 1994.

E–Learning Source

http://www.math.ucdavis.edu/~hunter/book/ch5.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Learn and analyse the central concepts of Banach Space, continuous linear transformation, Hahn-Banach Theorem and its applications.	K2
CO2	Know about natural imbedding, open mapping theorem and anayse its properties.	K2
CO3	Analyse axiomatic knowledge of the properties of a Hilbert space, including orthogonal complements, orthonormal sets,complete orthonormal sets together with related identities and inequalities and relate.	K3
CO4	Master the relevance of operator theory.	K5
CO5	Discuss analyse about preliminaries on Banach algebras and spectrum of an operator.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics		
Core – XIV	**Course Code:** 20PMA4C14	**Course Title:** Probability Theory

Semester	Hours/Week	Total Hours	Credits	Total Marks
IV	6	90	4	100

Course Objectives

To provide students with a strong foundation in Basic Probalility ,Variuous distributionand fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques

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: 1.1–1.7 and Chapter 2: Sections: 2.1–2.9).

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: 3.1–3.8).

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 – Characterstic function of multidimensional random vectors – Probability generating functions. (Chapter 4: Sections: 4.1–4.7).

Unit IV

Some probability distributions – One point, two point, Binomial – Polya –Poisson (discrete) distributions – Uniform – Normal gamma – Beta – Cauchy and Laplace (continuous) distributions. (Chapter 5: Sections: 5.1–5.10 (Omit Section 5.11).

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 – Lyapunov theorem. (Chapter 6: Sections: 6.1–6.4 & 6.6–6.9).

Text Book

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

References

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. Y.S. Chow and H. Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2^{nd} Edition).
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988 (3^{rd} Print).

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Recall the concepts of Random events, axioms of probability and Independent events.	K1&K2
CO2	Gain knowledge about marginal distributions, conditional distributions, moments and regressions.	K3
CO3	Understand the concepts of characteristic functions and Probability generating functions.	K1&K3
CO4	Analyse about the one-point, two-point distributions, Binomial distribution, Poisson distribution, Uniform distribution and Normal distribution.	K4
CO5	Analyze about the stochastic convergence.	K4&K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	S	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	S	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Core – XV	**Course Code:** 20PMA4C15		**Course Title:** Optimization Techniques	
Semester IV	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To understand the concepts of Operations Research. To know the methods for obtaining optimal solutions. To explore the applications of Operations Research in industries.

Unit I: Integer Linear Programming

Introduction – Illustrative applications integer programming solution algorithms: Branch and Bound (B & B) algorithm – Zero – One implicit enumeration algorithm – Cutting plane Algorithm. (Sections: 9.1, 9.2, 9.3.1. ,9.3.2 & 9.3.3).

Unit II: Deterministic Dynamic Programming

Introduction – Recursive nature of computations in DP – Forward and backward recursion – Selected DP applications cargo – Loading model – Work force size model – Equipment replacement model – Investment model. (Sections: 10.1, 10.2, 10.3, 10.4.1, 10.4.2, 10.4.3, 10.4.4 & 10.4.5).

Unit III: Decision Analysis and Games

Decision environment – Decision making under certainty (Analytical Hierarchy approach) Decision making under risk – Expected value criterion – Variations of the expected value criterion – Decision under uncertainty game theory – Optimal solution of two – Person zero – Sum games – Solution of mixed strategy games. (Sections: 14.1, 14.2, 114.3.1, 14.3.2, 14.4, 14.5.1 & 14.5.2).

Unit IV: Simulation Modelling

What is simulation? – Monte Carlo simulation – Types of simulation – Elements of discrete event simulation – Generic definition of events – Sampling from probability distributions – Methods for gathering statistical observations – Sub interval method – Replication method – Regenerative (Cycle) method – Simulation languages. Sections: 18.1, 18.2, 18.3, 18.4.1, 18.4.2, 18.5, 18.6, 18.7.1, 18.7.2, 18.7.3 & 18.8).

Unit V: Nonlinear Programming Algorithms

Unconstrained non linear algorithms – Direct search method – Gradient method constrained algorithms: Separable programming – Quadratic programming – Geometric programming –

Stochastic programming – Linear combinations method – SUMT algorithm. (Sections: 21.1.1, 21.1.2, 21.2.1, 21.2.2, 21.2.3, 21.2.4, 21.2.5 & 21.2.6).

Text Book

1. Hamdy A.Taha, Operations Research an Introduction, 8th Edison, University of Arkansas Fayetteville,2006

Reference Books

1. Philips D.T. Ravindra A. and Solbery J. Operations Research, Principles and Practice, John Wiley and Sons, New York.
2. B.E. Gillett, Operations Research – A Computer Oriented Algorithmic Approach, TMH Edition, New Delhi, 1976.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Understand integer programming techniques and their applications	K2
CO2	Understand determinisitic dynamic programming.	K2
CO3	Analyse decision making.	K3
CO4	Gain knowledge of simuation modelling.	K5
CO5	Analyse algorithm of NLP.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	S	S	S	S	S
CO2	M	M	S	S	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – IV (From Group – D)	**Course Code:** 20PMA4E10		**Course Title:** Number Theory	
Semester IV	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To understand the concepts of Number theory. To apply the techniques of congruence and some functions of number theory.

Unit I: Divisibility and Congruence

Divisibility – Primes – Congruences – Solutions of congruences – Congruences of degree one. (Chapter 1: Sections: 1.1–1.3 and Chapter 2: Sections: 2.1–2.3).

Unit II: Congruence

The function φ(n) – Congruence of higher degree – Prime power moduli – Prime modulus – Congruence's of degree two, prime modulus – Power Residues. (Chapter 2: Sections: 2.4–2.9).

Unit III: Quadratic Reciprocity

Quadratic residues – Quadratic reciprocity – The Jacobi symbol – Greatest Integer function. (Chapter 3: Sections: 3.1–3.3 and Chapter 4: Section: 4.1).

Unit IV: Some Functions of Number Theory

Arithmetic functions – The Mobius inverse formula – The multiplication of arithmetic functions. (Chapter 4: Sections: 4.2–4.4).

Unit V: Some Diaphantine Equations

The equation ax + by = c-Positive solutions – Other linear equations – The equation $x^2 + y^2 = z^2$ – The equation $x^4 + y^4 = z^2$ Sums of four and five squares – Waring's problem – Sum of fourth powers – Sum of two squares. (Chapter 5: Sections: 5.1–5.10)

Text Book

1. Ivan Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, 3rd Edition, Wiley Eastern Ltd., New Delhi, 1989.

Reference Books

1. D.M. Burton, Elementary Number Theory, Universal Book Stall, New Delhi, 2001.
2. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, New York, 1972.

3. T.M. Apostol, Introduction to Analytic Number Theory, Narosa Publication House, Chennai, 1980.

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Know the concepts of primes and congruences.	K2
CO2	Solve the problems of congruences of higher degree.	K2
CO3	Gain knowledge and analyze the concepts of quadratic residues, the Jacobi symbol and greatest integer function.	K3
CO4	Understand the notion of Arithmetic function and evaluate the positive division, the sum of positive divisions and the sum of the kth power of the positive divisions of a positive integer.	K5
CO5	Develop a deeper conceptual understanding to solve the equations x2 + y2 = z2 and x4 + y4 = z2.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	S	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	S	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – IV (From Group – D)	**Course Code:** 20PMA4E11		**Course Title:** Differential Geomentry	
Semester IV	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

This course introduces space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surfaces are explored.

Unit I: Theory of Space Curves

Theory of space curves – Representation of space curves – Unique parametric representation of a space curve – Arc-length – Tangent and osculating plane – Principle normal and binormal – Curvature and torsion – Behaviour of a curve near one of its points – The curvature and torsion of a curve as the intersection of two surfaces. (Chapter 1: Sections: 1.1–1.9) .

Unit II: Theory of Space Curves (Contd.)

Contact between curves and surfaces – Osculating circle and osculating sphere – Locus of centre of spherical curvature – Tangent surfaces – Involutes and evolutes – Intrinsic equations of space curves – Fundamental existence theorem – Helices. (Chapter 1: Sections: 1.10–1.13 & 1.16–1.18).

Unit III: Local Intrinsic Properties of Surface

Definition of a surface – Nature of points on a surface – Representation of a surface – Curves on surfaces – Tangent plane and surface normal – The general surfaces of revolution – Helicoids – Metric on a surface – Direction coefficients on a surface. (Chapter 2: Sections: 2.1–2.10).

Unit IV: Local Intrinsic Properties of Surface and Geodesic on a Surface

Families of curves – Orthogonal trajectories – Double family of curves – Isometric correspondence – Intrinsic properties – Geodesics and their differential equations – Canonical geodesic equations – Geodesics on surface of revolution. (Chapter 2: Sections: 2.11–2.15 and Chapter 3: Sections: 3.1–3.4) .

Unit V : Geodesic on a Surface

Normal property of Geodesics – Differential equations of geodesics using normal property – Existence theorems – Geodesic parallels – Geodesic curvature – Gauss Bonnet theorems –

Gaussian curvature – Surface of constant curvature. (Chapter 3: Sections: 3.5–3.8 & Sections: 3.10–3.13).

Text Book

1. D. Somasundaram, Differential Geometry, Narosa publications House, Chennai, 2005.

Reference Books

1. T. Willmore, An Introduction to Differential Geometry, Clarendan Press, Oxford, 1959.
2. D.T. Struik, Lectures on Classical Differential Geometry, Addison – Wesely, Mass, 1950.
3. J.A. Thorpe, Elementary Topics in Differential Geometry, Springer–Verlag, New York, 1979.

E–Learning Source

http://www.math.ku.dk/noter/filer/geom1.pdf

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Define and understand basic notions of the theory of curves and surfaces.	K2
CO2	Interpret notions of surface of revolution and direction coefficients.	K2
CO3	Possess adequate knowledge about isometric correspondence between curves and underlying notions about geodesics.	K3
CO4	Apprehend role of geodesics and it is emphasized on Gauss-Bonnet theorem.	K5
CO5	Assess a thorough grounding in principal curvatures impact on developable of a curve and minimal surface.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	M	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	S	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Elective – IV (From Group – D)		**Course Code:** 20PMA4E12	**Course Title:** Mathematical Statistics – II	
Semester IV	**Hours/Week** 6	**Total Hours** 90	**Credits** 4	**Total Marks** 100

Course Objectives

To apply statistical techniques for interpreting and drawing conclusion for business problem.

Unit I: Multiple and Partial Correlation

Partial correlation – Partial correlation coefficient – Partial correlation in case of four variables – Multiple correlations – Multiple regression. (Chapter 16: Pages: 16.1–16.21).

Unit II: Time Series

Components of time series – Secular trend – Seasonal variation – Cyclical variation – Irregular variation – Measures of trend – Graphic method – Semi average method – Moving average method – Period of moving average – Method of least squares – Measures of seasonal variation – Method of averages – Moving average method – Ratio to a moving average method – Ratio to trend method. (Chapter 37: Pages: 37.1–37.22).

Unit III: Sampling

Sampling: Sampling methods, sampling error and standard error – Relationship between sample size and standard error – Testing hypothesis: Testing of means and proportions – Large and small samples – z-test and t-test. (Chapter 24: Pages: 24.1–24.44 & 26.1–26.45).

Unit IV: F Distribution

F Distribution – Testing equality of population variances – Analysis of variance – One way and two way classification. (Chapter 27: Pages: 27.1–27.29).

Unit V: Chi-square Distribution

Chi-square distribution – Characteristics and application – Test of goodness of fit and test of independence – Test of homogeneity. (Chapter 28: Pages: 28.1–28.44).

Note: The Proportion between theory and problem shall be 1:4.

Text Book

1. P.R. Vittal and V. Malini, Statistical and Numerical Methods, Margham publications, Chennai, 2002.

Reference Books

1. S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics, 11-e, Sultan Chand

& Sons, New Delhi, 2004.

2. S.P. Gupta, Statistics Methods, Sultan Chand & Sons, New Delhi, 2000.
3. Richard I Levin and David S. Rubit, Statistics for Management, Seventh edition, Pearson Education, New Delhi, 2001.
4. D.C. Sancheti and V.K. Kapoor, Business Statistics 2-e, Sultan Chand & Sons, New Delhi 1979.

E–Learning Source

http://www.college stats.org/

Course Outcomes (COs)

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

CO Number	CO Statement	Knowledge Level
CO1	Recall the concepts of correlation.	K2
CO2	Understand the concepts of time series and its applications.	K2
CO3	Gain knowledge of sampling.	K3
CO4	Analyse about F-Distribution.	K5
CO5	Analyse about Chi-Square Distribution.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	M	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Mathematics				
Project	**Course Code:** 20PMA4PR01		**Course Title:** Project	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
IV	6	90	5	100

Project Work: 30 to 40 pages.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	S	S	S
CO3	M	M	M	S	S	S	S	S
CO4	M	M	M	S	S	S	S	S
CO5	M	M	M	S	S	S	S	S

S – Strong **M – Medium** **L – Low**