

PROGRAMME PROJECT REPORT (PPR)

MASTER OF SCIENCE

IN

Mathematics

(M. Sc. Mathematics)



MATS Centre for Distance and Online Education (MCDOE)

MATS University, Raipur, Chhattisgarh

MATS UNIVERSITY: VISION

To become a world-class center in providing globally relevant education. MATS will be the Global University, known for the quality academic programmes and outstanding faculty, products, and services to students and clients independent of place and time constraints. MATS University will be a benchmark institution for lifelong partnerships with students, the workforce, and public and private enterprises. Building on its proud tradition, MATS University will extend educational opportunities to those who will make our state (Chhattisgarh), our nation, and global society a better place to live and work.

MATS UNIVERSITY: MISSION

To foster an intellectual and ethical environment in which the spirit and skills within MATS will thrive so as to impart high quality education, training, research and consultancy services with a global outlook and human values. To create and develop technocrats, entrepreneurs and business leaders who will strive to & improve the quality of human life. To create truly world class schools of Management Sciences, Engineering Sciences, Information Technology, Life Science, Basic and Applied Sciences, Humanities & Social Sciences and Life Skills.


Dr. A. I. Khan (HOD)


Dr. Vinita Dewangan


Dr. Achal Mishra



Programme's Mission and Objectives:

Mission:

The mission of the Open and distance learning Master of Science in Mathematics (M.Sc. Mathematics) programme is to create technocrats in the applied branches of Mathematical Sciences to convey updated scientific knowledge. Mathematics is the industry & research-oriented science and can be applied in developing various field of science and technology. The updated knowledge of the subject both theoretical and practical will make them compatible to secure plenty of opportunities in Mathematics field through distance learning education. Following is the mission of this programme:

- The Mathematics Education route is for individuals with a research or professional interest in mathematics education at the postgraduate level.
- It is designed for those seeking advanced study in a world-class setting as well as engaging in research.

Objectives:

The open and distance learning Master of Science in Mathematics (M.Sc. Mathematics) programme is a two-year postgraduate programme that focuses on Mathematical Calculations.

Objectives of the Program:

1. The **Master of Science (Mathematics)** program is structured through the distance mode to promote scientific temperament in higher education.
2. It aims to provide easy access to learners who want to improve their qualifications, skills, and competencies.
3. The program is designed to be theoretical, preparing learners for careers as mathematicians in industry and entrepreneurship.

Relevance of the Programme with University's Mission

and Goals:

The open and distance learning M. Sc. Mathematics programme aligns with MATS University's mission to cultivate a learning environment that encourages creativity, innovation, and critical thinking. It is designed to offer a high-quality education in Mathematics sciences, equipping students with the knowledge and skills needed to excel in the field of maths. The programme focuses on developing competent



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professionals capable of making meaningful contributions to industry and society. The program offers practical and project-based learning, students enhance their teamwork, problem solving approach, communication skills and essential qualities in the vibrant field of Mathematical science. this program will provide ample of opportunities to those rural and backward learners who are deprived of Maths science education and cannot find a place in regular education system. Apart from that it is also open to those who wish to continue their learning irrespective of their rural background and economically poor families.

Nature of Prospective Target Group of Learners:

The program is exclusively for learners who are unable to achieve their educational goals through the traditional method of instruction are the target audience for this programme, which was developed expressly to satisfy their needs. Our target population of learners consists of individuals who are working professionals, housewives, who live in tribal or rural areas, and who are unable to participate in the normal curriculum for a variety of reasons. Individuals who are interested in enrolling themselves in this particular program are required to have a degree that is equivalent to or equivalent to a graduation from any field. The prospective learners can be graduates of science /Engineering faculty (with mathematics as a subject), who wishes to pursue their career in the field of mathematics.

Appropriateness of program to be conducted in Open and Distance Learning mode to acquire specific skills and competence:

Master of Science [Mathematics] is one of the suitable course/programs to be offered through Open and Distance Learning mode. Theoretical mode can be well acquired through the distance learning mode.

Appropriateness of programme to be conducted in Open and Distance Learning mode to acquire specific skills and competence:

The open and distance learning mode of MATS University system places greater emphasis on the learner, where most of the instruction is delivered through distance mode with only a minimal component of face-to-face communication. Students will









have the flexibility to learn at their intellectual strength. The content of teaching learning has been prepared in such a way that the students taking admission in open distance learning education system will not face any problem in studying and understand the content they can easily access course materials and resources available. Those students who are enrolled in classes that are provided through Open Distance Learning will have the opportunity to learn in an environment that is driven by technology. This environment will include learning materials, classroom discussions, and a range of tools that can be used to collaborate with both classmates and instructors. In order to facilitate the development of analytical, problem-solving, and critical-thinking skills, this provides a learning environment that is not only immersive but also interesting. Master of Science [Mathematics] is one of the suitable course/programmes to be offered through Open and Distance Learning mode. Theoretical mode can be well acquired through the distance learning mode.

Instructional Design:

Curriculum Design, Detailed Syllabi and Duration:

The M.Sc. Mathematics programme of MATS Centre for Open and Distance Education, offers run for the period of two years which is divided in four semesters. This programme comes under the MATS School of Sciences. M.Sc. Mathematics is a postgraduate programme designed to provide in-depth knowledge of chemical science, covering fundamental to advanced concepts and their applications.

Credit Points:

All courses within this program provided by MATS Distance Learning Education assign "credit points," which represent a numerical value attributed to a course, indicating the requisite effort and study for successful completion, and are employed to determine if the conditions for an award have been met. Maintain a specific value as credit points. A credit point denotes the number of learning hours necessary to complete a specific unit of a course. One credit point corresponds to 15 learning hours, which encompass self-study, contact classes, assignments, projects, and all activities associated with the program required to obtain the postgraduate degree.



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Total credits of the M.Sc. Mathematics programme are 84. The Teaching & Examination Scheme is as follows:

Semester-wise distribution of Credits for MBA:

	Theory	Practical	+
I. Core Course (13 Papers)	13×4 = 52	2×3=6	
II. Core Course with practical (02 Papers)			
I. Core Course Practical / Tutorial*(02 Papers)	2×2 = 4		
II. Elective Course (4 Papers)	4×4 = 16		
III. Dissertation	1×6=6		
Total Credit	84		

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Teaching & Examination Scheme (Matrix M.Sc. Mathematics):

First Semester I:

Subject Code	Name of Subject	Credit Theory	Credit Lab/Tutorial	ESE Marks	Internal Marks	Total Marks
MSCMODL101	ALGEBRA	4		70	30	100
MSCMODL102	REAL ANALYSIS	4		70	30	100
MSCMODL103	DIFFERENTIAL EQUATIONS	4		70	30	100
MSCMODL104	DISCRETE MATHEMATICS	4		70	30	100
MSCMODL105	Elective I: Numerical Methods / Mathematical Statistics	4		70	30	100
Total		20				500

Second Semester II:

Subject Code	Name of Subject	Credit Theory	Credit Lab/Tutorial	ESE Marks	Internal Marks	Total Marks
MSCMODL201	COMPLEX ANALYSIS	4		70	30	100
MSCMODL202	PARTIAL DIFFERENTIAL EQUATIONS	4		70	30	100
MSCMODL203	LINEAR ALGEBRA	4		70	30	100
MSCMODL204	ATLAB	3		70	30	100
MSCMODL205	ATLAB		2	35	15	50
MSCMODL206	Elective II: Distribution theory / Information Theory	4		70	30	100
Total		19	2			550



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Third Semester III:

Subject Code	Name of Subject	Credit Theory	Credit Lab/Tutorial	ESE Marks	Internal Marks	Total Marks
MSCMODL 301	TOPOLOGY	4		70	30	100
MSCMODL 302	MATHEMATICAL METHODS	4		70	30	100
MSCMODL 303	FUNCTIONAL ANALYSIS	4		70	30	100
MSCMODL 304	LATEX & MATHEMATICA	3		70	30	100
MSCMODL 305	LATEX & MATHEMATICA		2	35	15	50
MSCMODL 306	Elective III: Graph Theory / Number Theory & Combinatorics	4		70	30	100
Total		19	2			550

Fourth Semester IV:

Subject Code	Name of Subject	Credit Theory	Credit Lab/Tutorial	ESE Marks	Internal Marks	Total Marks
MSCMODL401	NONLINEAR DIFFERENTIAL EQUATION	4		70	30	100
MSCMODL402	OPERATION RESEARCH	4		70	30	100
MSCMODL403	FUZZY SETS THEORY	4		70	30	100
MSCMODL404	Elective IV: Approximation Theory / Mathematical Modeling	4		70	30	100
MSCMODL405	PROJECT/DISSEMINATION	6				200
Total		22				600

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First Semester

Algebra Theory

Course Outcome(s): After completing this course, the student will be able to:

CO-1 Explain the fundamental concepts of advanced abstract algebra and their role in modern mathematics and applied contexts.

CO-2 Able to utilize application of rings.

CO-3 Knowledge of extension fields and its applications.

CO-4 Understand the concepts Galois Theory and concept of polynomial of radicals.

CO-5 Understand the connection and transition between previously studied mathematics and more advanced mathematics.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
ALGEBRA Subject code - MSCMOD L101	CO 1 - Explain the fundamental concepts of advanced abstract algebra and their role in modern mathematics and applied contexts.	1,2	1
	CO 2 - Able to utilize application of rings.	3,4,5	1,2
	CO 3 - Knowledge of extension fields and its applications.	1,3	2,3
	CO 4 - Understand the concepts Galois Theory and concept of polynomial of radicals.	2,3	2
	CO 5 - Understand the connection and transition between previously studied mathematics and more advanced mathematics.	6,7,8,9	1,3

CO-PO and CO-PSO Mapping

Subject Code	ALGEBRA												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
MSCMOD L101													
CO101.1	2	1	-	-	-	-	-	-	-	-	1	-	-



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CO101.2	-	-	3	2	2	-	-	-	-	-	2	3	
CO101.3	2	-	2	-	-	-	-	-	-	-		2	2
CO101.4	-	2	1	-	-	-	-	-	-	-	-	2	-
CO101.5	-	-	-	-	-	2	3	3	2	-	1	-	2
CO101.1	2	2	1	2	2	2	2	2	2	2	2	2	2

**Note: 1- Low relation
2- Average relation
3- Good relation**

Unit-I:

Group theory: Direct products- Group action on a set: Isotropy subgroups- Orbits- Application of G-Sets to Counting: Counting theorems- p-Groups- The Sylow theorems.

Unit-II:

Applications of the Sylow theory: Applications to p-groups and the class equation- Further applications. Ring theory: Rings of polynomials: Polynomials in an indeterminate - The evaluation homomorphism - Factorization of polynomials over a field.

Unit-III:

Field theory: Extension fields-algebraic and transcendental elements-Irreducible polynomial over F - Simple extensions- Algebraic extensions: Finite extensions- Structure of a finite fields.

Unit - IV:

Automorphisms of fields- Conjugation isomorphisms- Automorphisms and fixed fields- The Frobenius automorphism- Splitting fields.

Unit-V:

Separable extensions- Galois theory: Normal extensions- The main theorem- Illustrations of Galois theory: Symmetric functions

Books Recommended:

- 1.A First Course in Abstract Algebra by **J.B. Fraleigh**, Fifth Edition, Addison-Wesley Longman, Inc, Reading Massachusetts, 1999.
2. Topics in Algebra by **I.N. Herstein**, Blaisdell, New York, 1964.
3. Algebra by **M. Artin**, Prentice-Hall of India, New Delhi, 1991.

**REAL ANALYSIS
THEORY**

Total Marks: 100 (70+30)

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Course Objective(s): To learn the concepts of basic topological objects such as open sets, closed sets, compact sets and the concept of uniform convergence and also to work comfortably with continuous, differentiable and Riemann integrable functions, Sequences And Series Of Functions, Functions Of Several Variables, : Lebesgue Measure And The Lebesgue Integral.

Course Outcome(s): After completing this course, the student will be able to:

CO1: Attain mastery in Riemann integrable functions, Countable and Uncountable set.

CO2: Locate Sequence and Series, point wise and uniform convergent sequences.

CO3: Enumerate the concept of differentiation and Functions of Several Variables.

CO4: Study Briefly the Measurable sets and integration of series.

CO5: Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty like Lebesgue Measure And The Lebesgue Integral.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
REAL ANALYSIS Subject code - MSCMODL102	CO 1 - Attain mastery in Riemann integrable functions, Countable and Uncountable set.	4, 5, 7, 9	1, 3
	CO 2 - Locate Sequence and Series, point wise and uniform convergent sequences.	3, 5, 7, 8	2, 3

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	CO 3 – Enumerate the concept of differentiation and Functions of Several Variables.	1 ,2, 4, 6, 8, 10	1, 3
	CO 4 – Study Briefly the Measurable sets and integration of series.	3, 4, 6, 8, 9	1, 3
	CO 5 - Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty like Lebesgue Measure And The Lebesgue Integral.	3, 7, 9, 10	1, 2

CO-PO and CO-PSO Mapping

Subject Code	REAL ANALYSIS												
	MSCMODL1 02												
Course outcomes CO MSCMODL1 02	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO102.1	-	-	-	2	3	-	2	-	1	-	1	-	2
CO102.2	-	-	2	-	2	-	1	3	-	-	-	2	1
CO102.3	2	2	-	3	-	2	-	1	-	3	1	-	2
CO102.4	-	-	1	2	-	2	-	3	2	-	1	-	2
CO102.5	-	-	2	-	-	-	2	-	2	3	2	3	-

Note: 1- Low relation
 2- Average relation
 3- Good relation

Unit-I:

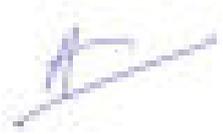
RIEMANN STIELTJES INTEGRAL: Definition and existence of the integral – Properties of the integral – Integration and differentiation – Integration of vector-valued functions – Rectifiable curves.

Unit-II:

SEQUENCES AND SERIES OF FUNCTIONS: Uniform convergence-Uniform convergence and continuity – Uniform convergence and integration – Uniform convergence and differentiation – Equicontinuous families of functions – The Stone-Weierstrass theorem.

Unit-III:

FUNCTIONS OF SEVERAL VARIABLES Linear transformations –Differentiation - The contraction principle – The inverse function theorem – The implicit function theorem – Determinants – Derivatives of higher order – Differentiation of integrals.


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Unit-IV:

LEBESGUE MEASURE Outer measure – Measurable sets and Lebesgue measure – Nonmeasurable set- Measurable functions – Littlewood’s three principles.

Unit-V:

THE LEBESGUE INTEGRAL The Lebesgue integral of a bounded function over a set of finite measure –The integral of a nonnegative function – The general Lebesgue integral – Convergence in measure.

Books Recommended:

- 1.Principles of Mathematical Analysis by **W. Rudin**, McGraw-Hill, New York, 1976
- 2.Real Analysis by **H.L. Royden**, Third Edition, Macmillan, New York, 1988

DIFFERENTIAL EQUATIONS

TITLE

Total Marks: 100 (70+30)

Course Objective(s): To study Linear Equations with Linear Equations with constant coefficient and Variable Co-efficient, Homogeneous and non-homogeneous equations of order n ,Linear equation with regular singular points, and Exact equations.

Course Outcome(s): After completing this course, the student will be able to:

- CO1 Students will have a working knowledge of important mathematical concepts in Ordinary and Differential Equations.
- CO2 Comprehend the Homogeneous and non-homogeneous equations of order n.
- CO3 Study Linear equation with regular singular points.
- CO4 Analyze the Exact equations and solving them .
- CO5 Identify the equation with regular singular points and solve them.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
DIFFERENTIAL EQUATIONS Subject code - MSCMODL103	CO 1 - Students will have a working knowledge of important mathematical concepts in Ordinary and Differential Equations	1,4,6,8	1,2
	CO 2 - Comprehend the Homogeneous and non-homogeneous equations of order n	2,4,5,7,10	2,3
	CO 3 – Study Linear equation with regular singular points	3,5,6,8,9	1,3
	CO 4 – Analyze the Exact equations and solving them	4,6,7,8,10	1,2,3



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	CO 5 - Identify the equation with regular singular points and solve them	3,5,7,9,10	2,3
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CO-PO and CO-PSO Mapping

Subject	DIFFERENTIAL EQUATIONS												
Code	MSCMODL103												
Course outcomes CO MSCMODL103	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO103.1	2	-	-	2	-	1	-	3	-	-	1	3	-
CO103.2	-	2	-	2	3	-	1	3	-	3	-	2	1
CO103.3	-	-	2	-	3	2	-	1	2	-	2	-	2
CO103.4	-	-	-	2	-	3	2	1	-	2	2	3	2
CO103.5	-	-	2	-	3	-	2	-	2	3	-	2	2

Note:
1- Low relation
2- Average relation
3- Good relation

Unit-I:

Linear equations with constant coefficients: The second order homogeneous equations – Initial value problems – Linear dependence and independence - A formula for the Wronskian – The non-homogeneous equation of order two.

Unit-II:

Homogeneous and non-homogeneous equations of order n – Initial value problems – Annihilator method to solve a non-homogeneous equation – Algebra of constant coefficient operators.

Unit-III:

Linear equations with variable coefficients: initial value problems for the homogeneous equation- Solutions of the homogeneous equation – The Wronskian and linear independence –Reduction of the order of a homogeneous equation - Homogeneous equation with analytic coefficients – The Legendre equation.

Unit-IV:

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

Unit-V:

Existence and uniqueness of solutions to first order equations: Equation with variables separated– Exact equations
 – The method of successive approximations – The Lipschitz condition –Convergence of the successive approximations.

Books Recommended:

1.An Introduction to Ordinary Differential Equations by **E.A. Coddington**, Prentice Hall of India Ltd., New Delhi, 1957

DISCRETE MATHEMATICS**THEORY****Total Marks: 100 (70+30)**

Course Objective(s): To study Relation, Lattices, Grammar, Boolean algebra and graph theory with the various applications.

Course Outcome(s): After completing this course, the student will be able to:

CO 1 - Study Congruence relation and quotient semigroups, Lattices.

CO 2 - Understand the finite automata, Moore and mealy machines.

CO 3 – Express the Boolean algebra as lattices and its applications.

CO 4 – Understand the Graph and its types.

CO 5 - Discuss the various algorithms for shortest route.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
DISCRETE MATHEMATICS Subject code - MSCMODL104	CO 1 - Study Congruence relation and quotient semigroups, Lattices.	2,4,5,7,9	1,3
	CO 2 - Understand the finite automata, Moore and mealy machines.	3,5,7,8,10	2,3
	CO 3 – Express the Boolean algebra as lattices and its applications.	1,4,5,6,8,10	1,3
	CO 4 – Understand the Graph and its types.	2,4,5,6,8,9	2,3
	CO 5 - Discuss the various algorithms for shortest route.	1,2,4,6,7,8	1,3

CO-PO and CO-PSO Mapping

Subject	DISCRETE MATHEMATICS								
Code	MSCMODL1								



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Course	04												
outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
MSCMOD L104													
CO104.1	-	2	-	3	2	-	1	-	2	-	1	-	3
CO104.2	-	-	2	-	2	-	3	1	-	1	-	2	2
CO104.3	2	-	-	2	1	3	-	2	-	2	2	-	3
CO104.4	-	2	-	3	2	2	-	3	2	-	-	2	2
CO104.5	2	2	-	1	-	2	1	3	-	-	3	-	1
Average CO MSCMOD L104													

Note: 1- Low relation

2- Average relation

3- Good relation

Unit I

Recurrence Relations and Generating Functions, Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

Unit II

Statements Symbolic Representation and Tautologies, Quantifiers, Predicates and validity, Propositional Logic. Lattices as partially ordered sets, their properties, Lattices as Algebraic systems. Sub lattices, Direct products and Homomorphism, Some special lattices e.g. complete, Complemented and Distributive Lattices.

Unit III

Boolean Algebras as Lattices, Various Boolean Identities, The switching Algebra. Example, Subalgebras, Direct Products and Homomorphism, Joint-irreducible elements, Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of Products, Cononical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates.) The Karnaugh method.

Unit IV

Finite state Machines and their Transition table diagrams, Equivalence of Finite State, Machines, Reduced Machines, Homomorphism. Finite automata, Acceptors, Nondeterministic, Finite Automata and equivalence of its power to that of deterministic Finite automata, Moore and Mealy Machines.

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Unit V : Grammars and Language: Phrase-Structure Grammars, Requiring rules, Derivation, Sentential forms, Language generated by a Grammar, Regular, Context -Free and context sensitive grammars and Languages, Regular sets, Regular Expressions and the pumping Lemma. Kleene's Theorem. Notions of Syntax Analysis, Polish Notations. Conversion of Infix Expressions to Polish Notations. The Reverse Polish Notation.

Books Recommended:

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, Fourth Edition.
2. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York.
3. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition.
4. J.P. Tremblay, R. Manohar, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt.Ltd.
5. J.E. Hopcraft and J.D.Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House.
6. M. K. Das, Discrete Mathematical Structures for Computer Scientists and Engineers, Narosa Publishing House.
7. C. L. Liu and D.P.Mohapatra, Elements of Discrete Mathematics- A Computer Oriented Approach, Tata McGraw-Hill, Fourth Edition.

ELECTIVE 1

THEORY

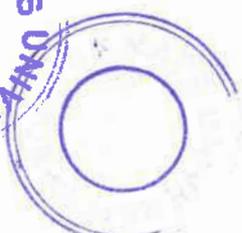
Total Marks: 100 (70+30)

NUMERICAL METHODS

Course Objective(s): Numerical Analysis deals with numerical solutions of certain problems of Mathematics. In this course we study an application of Numerical Integration, Types of partial differential equations and their solutions.

Course Outcome(s): After completing this course, the student will be able to:

- CO1: Obtain the solutions of Higher Order Derivatives numerically.
- CO2: Express the System of equations and higher Order Equation.
- CO3: Apply the Shooting Method, the alternating direction Implicit Method.



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CO4: State Types of partial differential equations.

CO5: Express the elements of ordinary differential equations.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
NUMERICAL METHODS Subject code - MSCMODL 105	CO 1 - Obtain the solutions of Higher Order Derivatives numerically.	2,3,5,7,9	1,3
	CO 2 - Express the System of equations and higher Order Equation.	3,4,6,8,9	2,3
	CO 3 - Apply the Shooting Method, the alternating direction Implicit Method.	1,3,4,6,7,10	1,3
	CO 4 - State Types of partial differential equations.	1,3,5,6,8,9,10	1,2,3
	CO 5 - Express the elements of ordinary differential equations.	2,3,5,6	2,3

CO-PO and CO-PSO Mapping

Subject	NUMERICAL METHODS												
Code	MSCMODL 105												
Course outcomes CO MSCMODL 105	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO105.1	-	2	1	-	2	-	2	-	3	-	1	-	2
CO105.2	-	-	2	3	-	2	-	1	2	-	-	2	1
CO105.3	2	-	1	2	-	3	2	-	-	3	2	-	3
CO105.4	2	-	2	3	1	-	-	3	2	3	2	1	2
CO105.5	-	2	3	-	2	3	-	-	-	-	-	2	3

Note: 1- Low relation

2- Average relation

3- Good relation

Unit-I

Introduction, difference calculus, difference operator, linear difference equations, first order equations, general results for linear equations, equations with constant coefficients, equations with variable coefficients.

Unit-II

Classification of partial differential equations, Dirichlet's problem, Cauchy's problem, Finite difference

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approximations to partial derivatives, Elliptic equation, Numerical solutions of Laplace and Poisson equations, Solution to elliptic equations by relaxation method, solution by Laplace equation by Alternating Direction Implicit (ADI) method.

Unit-III

Parabolic equations, Numerical solution of one dimensional diffusion & heat equations, Schmidt method, Crank-Nicholson method, Iterative methods-Dufort and Frankel method.

Unit-IV

Hyperbolic equations, the one dimensional wave equation, Numerical solutions of one-dimensional wave equation, Numerical solution of one dimensional wave equation by difference schemes, central-difference schemes, D'Alembert solution.

Unit-V

Variational finite element method with application to one-dimensional problem, solution of time dependent problems in one dimension and two dimension & steady state problems using Ritz's method.

Books Recommended:

1. Difference Equation-An Introduction with Applications by Walter G. Kelley and Allan C. Peterson, Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.
2. Numerical Solution of Differential Equations by M.K.Jain, New Age International (P) Limited, Publishers.
3. Applied Numerical Analysis by Gerald & Wheatley, Pearson Education.

MATHEMATICAL STATISTICS

Course Objective(s): To study probability density function, Mathematical Expectation, Marginal and Conditional distributions, Some Special Distributions.

Course Outcome(s): After completing this course, the student will be able to:

CO1: Understand Descriptive statistics and discrete probability.

CO2: Study Random variables and distribution function and applications.

CO3: Apply the standard discrete and continuous univariate distribution.

CO4: Study the Tests of hypothesis, Analysis of discrete data and chi-square test.

CO5: Understand Multivariate normal distribution, partial and multiple correlation coefficients and related tests



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Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
MATHEMATICAL STATISTICS Subject code - MSCMODL 105	CO 1 - Understand Descriptive statistics and discrete probability.	1,3,4,5	1,2
	CO 2 - Study Random variables and distribution function and applications.	2,3,5,6	2,3
	CO 3 – Apply the standard discrete and continuous univariate distribution.	2,4,5,7	1,3
	CO 4 – Study the Tests of hypothesis, Analysis of discrete data and chi-square test.	3,4,6,8,9	2,3
	CO 5 - Understand Multivariate normal distribution, partial and multiple correlation coefficients and related tests	5,7,8,9	1,2,3

CO-PO and CO-PSO Mapping

Subject	MATHEMATICAL STATISTICS															
Code	MSCMODL105															
Course outcomes CO MSCMODL 105	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3			
CO105.1	2	-	3	2	1	-	-	-	-	-	2	3	-			
CO105.2	-	2	3	-	2	1	-	-	-	-	-	2	3			
CO105.3	-	2	-	3	2	-	3	-	-	-	1	2	-			
CO105.4	-	-	2	2	-	3	-	2	1	-	-	2	1			
CO105.5	-	-	-	-	2	-	2	1	2	-	2	1	2			

Note: 1- Low relation

2- Average relation

3- Good relation

Unit - I

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Unit - II

Random variable and probability functions: Definition and properties of random variables,



Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions. Mathematical expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties.

Unit - III

Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties. Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Unit - IV

Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors. Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.

Books recommended :

1. V. Hogg and T. Craig, Introduction to Mathematical Statistics , 7th addition, Pearson Education Limited-2014
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill Book Company.
3. J.E. Freund, Mathematical Statistics, Prentice Hall of India.
4. M. Spiegel, Probability and Statistics, Schaum Outline Series.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

SECOND SEMESTER

COMPLEX ANALYSIS THEORY

Total Marks: 100 (70+30)

Course Objective(s): To study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integrals and harmonic functions, Jacobian of a transformation, conformal mapping.

Course Outcome(s): After completing this course, the student will be able to:



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CO1: Analyze Analytic functions and harmonic functions.

CO2: Apply Cauchy's theorem for disk and the Integral formula.

CO3: Understand Local properties of Analytic functions.

CO4: Study Power series Expansions and the The Riemann mapping theorem.

CO5: Differentiate the Taylor's series and Laurent series.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
COMPLEX ANALYSIS Subject code – MSCMODL 201	CO 1 - Analyze Analytic functions and harmonic functions.	3,5,6,7,9	2,3
	CO 2 - Apply Cauchy's theorem for disk and the Integral formula.	1,3,5,6,8,9,10	1,3
	CO 3 – Understand Local properties of Analytic functions	4,6,7,8,10	1,2,3
	CO 4 – Study Power series Expansions and the Riemann mapping theorem.	2,3,4,6,7,8	2,3
	CO 5 - Differentiate the Taylor's series and Laurent series.	3,5,8,9,10	1,2,3

CO-PO and CO-PSO Mapping

Subject Code	COMPLEX ANALYSIS												
	MSCMODL2 01												
Course outcomes CO MSCMODL2 01	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO201.1	-	-	2	-	1	2	3	-	2	-	-	2	2
CO201.2	2	-	2	-	1	3	-	2	3	1	1	-	2
CO201.3	-	-	-	2	-	3	3	2	-	1	1	2	1
CO201.4	-	2	1	2	-	3	2	2	-	-	-	2	2
CO201.5	-	-	2	-	2	-	-	3	1	1	2	2	1

Note: 1- Low relation

2- Average relation

3- Good relation

Unit-I:

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Introduction to the concept of analytic function: Limits and continuity – Analytic functions – Polynomials – Rational functions – Conformality: Arcs and closed curves – Analytic functions in regions – Conformal mapping – Length and area – Linear transformations: The linear group – The cross ratio – Elementary conformal mappings: Elementary Riemann surfaces.

Unit-II:

Fundamental theorems: Line integrals rectifiable arcs – Line integrals as functions of arcs – Cauchy's theorem for a rectangle - Cauchy's theorem in a disk, Cauchy's integral formula: The index of a point with respect to a closed curve – The integral formula – Higher derivatives -Local properties of analytical functions: Removable singularities, Taylor's theorem – Zeros and poles – The local mapping – The maximum principle –The general form of Cauchy's theorem: Chains and cycles.

Unit-III:

The calculus of residues: The residue theorem – The argument principle – Evaluation of definite integrals- Harmonic functions: Definition and basic properties – The mean-value property –Poisson's formula.

Unit-IV:

Power series Expansions : Weierstrass theorem – The Taylor series – The Laurent series–Partial fractions and factorization: Partial fractions – Infinite products – Canonical products.

Unit-V:

The Riemann mapping theorem: Statement and proof – Boundary behavior – Use of the reflection principle – Analytic arcs – Conformal mapping of polygons: The behavior at an angle– The Schwarz – Christoffel formula – Mapping on a rectangle.

Books Recommended:

1. Complex Analysis by L.V. Ahlfors, Third Edition, McGraw-Hill, New York, 1979

PARTIAL DIFFERENTIAL EQUATIONS THEORY

Total Marks: 100 (70+30)

Course Objective(s): To study Nonlinear partial differential equations of the first order, Linear Equations with constant and Variable Co-efficient, The solution of linear hyperbolic equations, Partial Differential Equations of the First order, Partial Differential Equations of the second order.

Course Outcome(s): After completing this course, the student will be able to:

CO1 Obtain solutions of the nonlinear partial differential equations of the first order.

CO2 Comprehend the Partial differential equations of second order.

CO3 Study the solution of linear hyperbolic equations.

CO4 Analyze the Laplace's equation.

CO5 Identify and Gain the knowledge of the wave equation.



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Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
PARTIAL DIFFERENTIAL EQUATIONS Subject code – MSCMODL202	CO 1 - Obtain solutions of the nonlinear partial differential equations of the first order.	2,4,5,6,8,9	2,3
	CO 2 - Comprehend the Partial differential equations of second order.	3,5,6,8,9,10	1,3
	CO 3 – Study the solution of linear hyperbolic equations.	1,3,5,6,7,9,10	1,2,3
	CO 4 – Analyze the Laplace’s equation.	4,6,8,9	2,3
	CO 5 - Identify and Gain the knowledge of the wave equation.	2,3,5,6,8,9	1,2,3

CO-PO and CO-PSO Mapping

Subject	PARTIAL DIFFERENTIAL EQUATIONS												
	MSCMODL202												
Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
Course outcomes CO MSCMODL202													
CO202.1	-	2	-	3	2	3	-	1	2	-	-	1	2
CO202.2	-	-	2	-	1	2	-	2	3	2	1	-	2
CO202.3	2	-	2	-	1	3	3	-	2	3	2	1	2
CO202.4	-	-	-	2	-	3	-	2	2	-	-	2	1
CO202.5	-	2	1	-	2	3	-	2	1	-	2	1	3

Note: 1- Low relation

2- Average relation

3- Good relation

Unit I: 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.

Unit II: Partial differential equations of second order: The origin of second-order equations – Linear partial differential equations with constant coefficients – Equations with variable coefficients –Characteristic curves of second–order equations- Characteristics of equations in three variables.

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Unit III: The solution of linear hyperbolic equations – Separation of variables – The method of integral transforms – Nonlinear equations of the second order.

Unit IV: Laplace's equation : The occurrence of Laplace's equation in physics- elementary solution of Laplace's equation – Families of equipotential surfaces - boundary value problems – Separation of variables- Problems with axial symmetry.

Unit V: The wave equation: The occurrence of wave equation in physics – Elementary solutions of the one-dimensional wave equation – vibrating membranes: Applications of the calculus of variations – Three dimensional problems. The diffusion equations: Elementary solutions of the diffusion equation – Separation of variables- The use of integral transforms.

Books Recommended:

1. *Elements of Partial Differential Equations* by I. N. Sneddon, McGraw-Hill Book Company, Singapore, 1957.

**LINEAR ALGEBRA
THEORY**

Total Marks: 100 (70+30)

Course Objective(s): This course objective is the basic concepts of linear algebra such as Vector Spaces And Linear Maps, Diagonalization And The Primary Decomposition Theorem, Unitary Transformations, The Jordan Canonical Form and brief introduction to their possible application.

Course Outcome(s): After completing this course, the student will be able to:

- CO1 Understand the vector spaces and Linear Maps also, Express the concept of Basis.
- CO2 Give the knowledge of The Primary Decomposition Theorem and its applications.
- CO3 Understand Unitary Transformations and its concept.
- CO4 Understand The Jordan Canonical Form.
- CO5 Able about the brief introduction to their possible application.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
LINEAR ALGEBRA Subject code – MSCMODL20 3	CO 1 - Understand the vector spaces and Linear Maps also, Express the concept of Basis.	2,4,5,6,8,10	2,3
	CO 2 - Give the knowledge of The Primary Decomposition Theorem and its applications	1,3,5,6,8,	1,3



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	CO 3 – Understand Unitary Transformations and its concept	4,5,6,8,9,10	1,2,3
	CO 4 – Understand The Jordan Canonical Form.	2,3,5,6,8,	2,3
	CO 5 - Abel about the brief introduction to their possible application	1,3,5,6,8,9	1,2,3

CO-PO and CO-PSO Mapping

Subject Code	LINEAR ALGEBRA												
Course outcomes CO MSCMODL2 03	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO203.1	-	2	-	3	1	2	-	2	-	3	-	2	1
CO203.2	2	-	2	1	3	-	-	1	-	-	2	-	3
* CO203.3	-	-	-	2	3	2	-	2	3	3	2	2	1
CO203.4	-	2	3	-	2	3	-	1	-	-	-	1	3
CO203.5	2	-	2	-	1	1	-	2	3	-	2	3	1

Note: 1- Low relation

2- Average relation

3- Good relation

UNIT I

Vector Spaces And Linear Maps: Vector spaces – Bases and dimension – Subspaces – Matrices and linear maps –rank nullity theorem - Inner product spaces-orthonormal basis – Gram-Schmidt Orthonormalization process.

UNIT II

Diagonalization And The Primary Decomposition Theorem: Eigen spaces-Algebraic and Geometric multiplicities – Cayley-Hamilton theorem Diagonalization – Direct sum decomposition – Invariant direct sums – Primary decomposition theorem.

UNIT III

Unitary Transformations: Unitary matrices and their properties-rotation matrices-Schur, Diagonal and Hessenberg forms and Schur Decomposition.

UNIT IV

The Jordan Canonical Form: Similarity Transformations and change of basis-Generalised eigen vectors-

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Canonical basis-Jordan canonical form – Applications to linear differential equations – Diagonal and the general cases.

UNIT V

Applications; An error-correcting code – The method of least squares – Particular solutions of nonhomogeneous differential equations with constant coefficients – The Scrambler transformation.

Books Recommended:

1. Hoffmann K. and Kunze R., “Linear Algebra”, Prentice Hall of India, 2nd Edition, 2000. (Sections: 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.4, 6.2, 6.4, 6.6, 6.7, 6.8, 8.2)
2. Ben Noble and James W. Daniel, “Applied Linear Algebra”, Prentice Hall International Inc, 3rd Edition, 1988. (Sections: 7.3 - 7.5, 8.2)
3. Agnew J. and Knapp R.C., “Linear Algebra with Applications”, Brooks/Cole Publishing Co., 1983. (Sections: 4.6, 5.4)
4. Gilbert Strang, “Linear Algebra and its applications”, Thomson, 3rd Edition, 1998.
5. S. Kumaresan, “Linear Algebra: A Geometric Approach”, Prentice Hall of India, 2006.

MATLAB

THEORY

Total Marks: 100 (70+30)

Course Objective(s): In this course we will study the basics of the Starting with Matlab, Script files, Two-dimensional plots - Three-dimensional plots, Programming in MATLAB and its applications

Course Outcome(s): After completing this course, the student will be able to:

CO 1 - Identify the basic concept of MAT LAB
CO 2 - Gain knowledge of Analyze Classes and Objects.
CO 3 – Understand Two-dimensional plots and Three-dimensional plots
CO 4 – Apply the concept of Extending Classes.
CO 5 - Understand how to build Elementary MATH Built.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
MATLAB	CO 1 - Identify the basic concept of MAT LAB	2,3,5,6,8,10	2,3
Subject code – MSCMODL204	CO 2 - Gain knowledge of Analyze Classes and Objects.	1,3,5,6,9	1,2,3



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	CO 3 – Understand Two-dimensional plots and Three-dimensional plots	2,3,5,6,9,10	1,3
	CO 4 – Apply the concept of Extending Classes.	3,5,6,8,9,10	2,3
	CO 5 - Understand how to build Elementary MATH Built.	1,2,5,8,9	2,3

CO-PO and CO-PSO Mapping

Subject Code	MATLAB												
	MSCMODL2 04												
Course outcomes CO MSCMODL2 04	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO204.1		2	3		1	2		2		2		2	2
CO204.2	2		2		1	3			3		2	3	1
CO204.3		2	3		2	2			1	3		3	2
CO204.4			3		2	2		2	2	1		2	2
CO204.5	2	2			1			1	2			2	3

Note: 1- Low relation

2- Average relation

3- Good relation

Unit – I:

Starting with Matlab - Creating arrays - Mathematical operations with arrays.

Unit – II:

Script files - Functions and function files.

Unit – III:

Two-dimensional plots - Three-dimensional plots.

Unit – IV:

Programming in MATLAB.

Unit – V:

Polynomials, Curve fitting and interpolation - Applications in numerical analysis.

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Books Recommended:

1. MATLAB An Introduction with Application” by **A. Gilat**, John Wiley & Sons, Singapore, 2004.
2. Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers” by **R. Prata p**, Oxford University Press, New Delhi, 2006.
3. “Introduction to Matlab 7 for Engineers” by **W.J. Palm**, McGraw-Hill Education, New York, 2005.
4. “Introduction to MATLAB 7” by **D. M. Etter, D. C. Kuncicky and H.Moore**, Prentice Hall, New Jersey, 2004.

**MATLAB
PRACTICAL**

Total Marks: 50 (35+15)

**ELECTIVE II
THEORY**

Total Marks: 100 (70+30)

DISTRIBUTION THEORY

Course Objective(s): This course objective is the basic and advanced concepts of distribution theory such as Test Functions And Distributions, Derivatives And Integrals, study of Convolutions And Fundamental Solutions, Green’s Functions, and brief introduction to their possible application.

Course Outcome(s): After completing this course, the student will be able to:

CO-1 Explain the fundamental concepts of advanced distribution theory and their role in modern mathematics and applied contexts.

CO-2 Able to know Derivatives And Integrals.

CO-3 Knowledge of Convolutions And Fundamental Solutions and its applications.

CO-4 Understand the concepts Green’s Functions.

CO-5 Understand the connection and transition between previously studied mathematics and more advanced mathematics.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
DISTRIBUTION THEORY Subject code – MSCMODL206	CO 1 - Explain the fundamental concepts of advanced distribution theory and their role in modern mathematics and applied contexts	2,3,5,6,8,9	1,3
	CO 2 - Able to know Derivatives And Integrals.	4,6,8,9,10	2,3
	CO 3 – Knowledge of Convolutions And Fundamental Solutions and its applications.	1,3,5,6,8,10	1,2,3



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	CO 4 – Understand the concepts Green’s Functions.	2,4,6,8,9	1,2
	CO 5 - Understand the connection and transition between previously studied mathematics and more advanced mathematics.	2,5,6,8,9	1,2

CO-PO and CO-PSO Mapping

Subject	DISTRIBUTION THEORY												
	MSCMODL2 06												
Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
Course outcomes CO MSCMODL 206													
CO206.1	-	2	3	-	2	1	-	1	2	-	2	-	2
CO206.2	-	-	-	2	-	3	-	2	2	1	-	1	3
CO206.3	2	-	2	-	1	3	-	3	-	2	2	3	1
CO206.4	-	2	-	3	-	2	-	2	1	1	1	-	-
CO206.5	-	2	-	-	3	3	-	2	1	2	2	-	-
MSCMODL 206													

Note: 1- Low relation

2- Average relation

3- Good relation

Unit - I:

Test Functions And Distributions: Test functions - Distributions - Localization and regularization - Convergence of distributions - Tempered distributions.

Unit - II:

Derivatives And Integrals: Basic Definitions - Examples - Primitives and ordinary differential equations.

Unit - III:

CONVOLUTIONS AND FUNDAMENTAL SOLUTIONS The direct product of distributions - Convolution of distributions – Fundamental solutions.

Unit - IV:

THE FOURIER TRANSFORM Fourier transforms of test functions - Fourier transforms of tempered distributions- The fundamental solution for the wave equation-Fourier transform of convolutions-Laplace transforms.

Unit - V:

GREEN’S FUNCTIONS Boundary-Value problems and their adjoints - Green’s functions for boundary-Value

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problems- Boundary integral methods.

Books Recommended:

1. An Introduction to Partial Differential Equations by **M. Renardy and R.C. Rogers**, Second Edition, Springer Verlag, New York, 2008.
2. “The Analysis of Linear Partial Differential Operators I – Distribution Theory and Fourier Analysis” by **L. Hörmander**, Second Edition, Springer Verlag, Berlin, 2003.
3. “Introduction to the Theory of Distributions” by **F.G. Friedlander and M. Joshi**, Cambridge University Press, UK, 1998.
4. “Generalized Functions - Theory and Technique” by **R.P. Kanwal**, Academic Press, New York, 1983.

INFORMATION THEORY

Course Objectives

To provide an insight into the Basic concepts of probability and its significance in the information theory..

To explore in detail, the calculations of channel capacity to support error-free transmission and also, the most commonly used source coding and channel coding algorithms.

To encourage and train to design coding schemes for data compression and error correction, and they will also get an overall perspective of how this impacts the design of an optimum communication receiver.

Course Outcomes

CO1: Overview of Probability Theory, significance of “Information” with respect to Information Theory.

CO2: Derive equations for entropy, mutual information and channel capacity for all kinds of channels.

CO3: Implement the various types of source coding algorithms and analyse their performance.

CO4: Explain various methods of generating and detecting different types of error correcting codes.

CO5: Understand the fundamentals of Field Theory and polynomial arithmetic.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
INFORMATION THEORY Subject code – MSCMODL206	CO 1 - Overview of Probability Theory, significance of “Information” with respect to Information Theory.	2,3,5,6,9	1,3
	CO 2 - Derive equations for entropy, mutual information and channel capacity for all kinds of channels.	3,5,8,10	1,2,3



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	CO 3 – Implement the various types of source coding algorithms and analyse their performance.	1,3,5,6,9	2,3
	CO 4 – Explain various methods of generating and detecting different types of error correcting codes.	2,3,5,8,10	1,2
	CO 5 - Understand the fundamentals of Field Theory and polynomial arithmetic.	1,3,5,6,9,10	1,2,3

CO-PO and CO-PSO Mapping

Subject	INFORMATION THEORY												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
Code	MSCMODL1 206												
Course outcomes CO MSCMODL 206													
CO206.1	-	2	1	-	2	3	-	-	1	-	1	-	2
CO206.2	-	-	2	-	3	-	-	2	-	1	2	2	3
CO206.3	2	-	1	-	2	3	-	-	2	-	-	3	2
CO206.4	-	2	2	-	1	-	-	1	-	3	3	2	-
CO206.5	2	-	3	-	1	2	-	-	2	3	3	2	2

Note: 1- Low relation

2- Average relation

3- Good relation

Unit - I

Basic concepts of probability, Sample spaces, Probability measure, Theorems of addition and multiplication, Conditional probability, Bayes Theorem Random, Variable, Discrete and continuous probability distributions Communication processes.

Unit - II

Entropy as a measure of uncertainty and information, Shannon's entropy and entropies of order, Algebraic properties and possible interpretations, Analytical properties and inequalities, Joint and conditional entropies, Mutual information. Noiseless coding, Unique decipherability, Conditions of existence of instantaneous codes, Its extension to uniquely decipherable codes, Noiseless coding theorem.

Unit - III

Construction of optional codes, Discrete memory less channels, Models for communication channel capacity, Clasification of channels, Calculation of channel capacity, Decoding scheme. fundamental theorems, Exponential

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error bound weak converse of Fundamental theorem.

Unit - IV

Extension of definition of entropies to continuous memory less channels and properties. Characterization theorem for entropies due to Shannon, Tevberg, Chaundy and Mechleod, Kandall, Daroczy, Campbell and Hayarda-Charvat.

Unit - V

Error correcting codes- maximum distance, Principal and error correcting properties, Gammings bounds, Paury coding, Upper and Lower bounds of parity check codes.

Books Recommended:

1. R. Ash, Information Theory, Interscience Publishers, New York, 1965.
2. F.M. Reza, An Introduction to Information Theory, MacGraw-Hill Book Company Inc., 1961.
3. J. Aczela and Z. Daroczy, On Measures of Information and their Characterizations, Academic Press, New York.
4. Mathai A.M. and Rathi P.N. : Axiomatic Foundations of some concepts of Information Theory.

THIRD SEMESTER

TOPOLOGY THEORY

Total Marks: 100 (70+30)

Course Objectives:

The prerequisite for the course is a first course in Analysis, at the level of Rudin's "Principles of Mathematical Analysis". In this course the students will be introduced the basic concepts of Topology. Definitions and examples of Topological Spaces, Open Bases, Open covering, Compact spaces, Hausdorff spaces, Separable spaces and totally disconnected spaces will be discussed. Proofs of important theorems such as Lindelof's Theorem, Tychonoff's Theorem, will be discussed.

Course Outcomes:

CO-1 In mathematics, topology is concerned with the properties of space that are preserved under continuous deformations, such as stretching, crumpling and bending, but not tearing or gluing, hence Topology is also known as rubber sheet geometry.

CO-2 On completion of the course students will understand that many concepts such as continuity, connectedness, compactness etc. are invariant under deformation of stretching and shearing.

CO-3 This course will give an insight into the beauty of mathematical argument and into qualitative approach to



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problem solving.

CO4: Discuss the components of a space and totally disconnected spaces.

CO5: Study Stone-Weierstrass theorems and its applications.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
TOPOLOGY Subject code – MSCMODL301	CO 1 - In mathematics, topology is concerned with the properties of space that are preserved under continuous deformations, such as stretching, crumpling and bending, but not tearing or gluing, hence Topology is also known as rubber sheet geometry.	2,4,5,6,8	2,3
	CO 2 - On completion of the course students will understand that many concepts such as continuity, connectedness, compactness etc. are invariant under deformation of stretching and shearing.	1,4,6,8,10	1,2,3
	CO 3 – This course will give an insight into the beauty of mathematical argument and into qualitative approach to problem solving.	2,5,6,8,9,10	2,3
	CO 4 – Discuss the components of a space and totally disconnected spaces.	1,3,5,7,8,9	1,2
	CO 5 - Study Stone-Weierstrass theorems and its applications	2,3,4,5,6,8,9	1,2,3

CO-PO and CO-PSO Mapping

Subject Code	TOPOLOGY												
	MSCMODL301												
Course outcomes CO MSCMODL301	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO301.1	-	2	-	2	3	1	-	3	-	-	-	1	3
CO301.2	2	-	-	2	-	3	-	1	-	3	2	1	2
CO301.3	-	2	-	-	1	2	-	3	3	1	-	2	1
CO301.4	2	-	3	-	2	-	2	1	2	-	2	2	-
CO301.5	-	2	3	2	1	2	-	-	2	3	1	2	2

Note: 1- Low relation

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2- Average relation

3- Good relation

Unit-I:

Spaces and maps: Topological spaces-Sets in a space-Maps-Subspaces-Sum and product of spaces.

Unit-II:

Identification and quotient spaces-Homotopy and isotopy.

Unit-III:

Properties of spaces and maps: Separation axioms and compactness.

Unit-IV

Connectedness – Pathwise connectedness – Imbedding theorems.

Unit-V

Extension theorems-Compactification-Hereditary properties.

Books Recommended:

1. Introduction to Topology by **S.T. Hu**, Tata – McGraw-Hill, New Delhi, 1979.
2. Topology by **J. Dugunji**, Allyn and Bagon, Boston, 1966.
3. Topology by **K. Kuratowski**, Academic Press, New york, 1966
4. Topology, A First Course ” by **J.R. Munkres**, Prentice Hall , Englewood Cliffs, 1975
5. General Topology by **S. Willard**, Addison-Wesley, Reading, 1970 .

MATHEMATICAL METHOD

THEORY

Total Marks: 100 (70+30)

Course Objective(s): This course gives the basic concept of Mathematical modelling, so that students from various fields like Engineering, Economics, Biology, Epidemiology etc. can apply its concept.

Course Outcomes: After completing this course, the student will be able to:

CO 1 - Discuss the basic features of mathematical modelling.

CO 2 - Apply the mathematical modeling using ODE of first order.

CO 3 – Explain the discrete model and its applications.

CO 4 – Get the application of The Method Of Variations In Problems With Fixed Boundaries.



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CO 5 - Discussed Sufficient Conditions For An Extremum.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
MATHEMATICAL METHOD Subject code – MSCMODL302	CO 1 - Discuss the basic features of mathematical modelling.	1,3,4,5,6,8,9	2,3
	CO 2 - Apply the mathematical modeling using ODE of first order.	2,3,5,6,8,9	1,2
	CO 3 – Explain the discrete model and its applications.	1,2,3,7,8,9,10	1,2,3
	CO 4 – Get the application of The Method Of Variations In Problems With Fixed Boundaries.	2,4,6,8	2,3
	CO 5 - Discussed Sufficient Conditions For An Extremum.	1,4,5,8	2,3

CO-PO and CO-PSO Mapping

Subject Code	MATHEMATICAL METHOD MSCMODL302												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO302.1	2	-	2	3	3	2	-	2	1	-	-	2	2
CO302.2	-	2	3	-	2	2	-	2	3	-	2	2	-
CO302.3	2	3	1	-	-	-	2	2	3	1	2	1	2
CO302.4	-	2	-	4	-	2	-	2	-	-	-	2	2
CO302.5	2	-	-	2	1	-	-	3	-	-	-	2	2

Note: 1- Low relation

2- Average relation

3- Good relation

Unit-I:

Integral Equations: Introduction: Integral equations with separable kernels - Reduction to a system of algebraic equations, Fredholm alternative, an approximate method, Fredholm integral equations of the first kind, method of successive approximations - Iterative scheme, Volterra integral equation, some results about the resolvent

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kernel, classical Fredholm theory - Fredholm's method of solution - Fredholm's first, second, third theorems.

Unit-II:

Applications Of Integral Equations : Application to ordinary differential equation - Initial value problems, boundary value problems - Singular integral equations - Abel integral equation.

CALCULUS OF VARIATIONS

Unit-III:

The Method Of Variations In Problems With Fixed Boundaries: Variation and its properties - Euler's equation - Functionals of the form $\int F(x,y_1,y_2,\dots y_n,y_1',y_2',\dots y_n')dx$, Functionals dependent on higher order derivatives - Functionals dependent on the functions of several independent variables - Variational problems in parametric form - Some applications. **Unit-IV: Sufficient Conditions For An Extremum: Field of extremals - The function $E(x,y,p,y')$ - Transforming the Euler equations to the canonical form.**

Unit-V:

Direct Methods In Variational Problems: Direct methods - Euler's finite difference method - The Ritz method - Kantorovich's method.

Books Recommended:

1. Linear Integral Equations - Theory and Technique by **R. P. Kanwal**, Second Edition, Birkhauser, Boston, 1997.
2. Differential Equations and the Calculus of Variations by **L. Elsgolts**, MIR Publishers, Moscow, 1970.
3. Integral Equations and Applications by **C. Corduneanu**, Cambridge University Press, Cambridge, 1991.
4. Calculus of Variations, with Applications to Physics and Engineering by **R. Weinstock**, McGraw-Hill Book Co., Inc., New York, 1952.

FUNCTIONAL ANALYSIS

THEORY

Total Marks: 100 (70+30)

Course Objectives:

The objectives of the course are to develop the theory needed to treat linear integral and differential equations, within the framework of infinite-dimensional linear algebra. Concepts of Normed spaces, Banach spaces, Hilbert spaces with examples are explained. Uniform boundedness principle and the open mapping theorem Banach Contraction Fixed point theorem and its generalization, Schauder's Fixed Point Theorem and applications of fixed point theorems are dealt with in detail.

Course Outcome(s): After completing this course, the student will be able to:



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CO1 Study Continuous linear transformations and the Hahn-Banach theorem.

CO2 Understand the, normed linearspaces of bounded linear transformations.

CO3 Obtain Orthogonal complements, Orthonormal sets and conjugate space.

CO4 Understand the Complete Orthonormal sets and Parseval's identity, Structure of Hilbert spaces.

CO5 Discuss Measurable functions.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
FUNCTIONAL ANALYSIS Subject code – MSCMODL303	CO 1 - Study Continuous linear transformations and the Hahn-Banach theorem.	2,3,4,5,8,9	2,3
	CO 2 - Understand the, normed linearspaces of bounded linear transformations.	1,3,5,6,8,10	1,3
	CO 3 – Obtain Orthogonal complements, Orthonormal sets and conjugate space	1,2,3,7,8,9	1,2,3
	CO 4 – Understand the Complete Orthonormal sets and Parseval's identity, Structure of Hilbert spaces	2,5,8,10	1,2
	CO 5 - Discuss Measurable functions	1,5,8	1,3

CO-PO and CO-PSO Mapping

Subject	FUNCTIONAL ANALYSIS												
Code	MSCMODL303												
Course outcomes CO MSCMODL303	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO303.1	-	2	1	2	2	-	-	3	2	-	-	2	3
CO303.2	2	-	3	-	1	2	-	2	3	-	2	-	3
CO303.3	2	3	3	-	-	-	2	1	2	-	2	2	1
CO303.4	-	2	-	-	3	-	-	2	-	2	2	3	-
CO303.5	1	-	-	-	2	-	-	3	-	-	1	-	3

Note: 1- Low relation

2- Average relation

3- Good relation

Unit-I:

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Banach spaces: Definition and examples – Continuous linear transformations – The Hahn Banach theorem .

Unit-II

The natural imbedding – Open mapping theorem – The conjugate of an operator.

Unit-III

Hilbert spaces: Definition and simple properties – Orthogonal complements – Orthonormal sets– Conjugate space.

Unit-IV

The adjoint of an operator-Self –adjoint operators-Normal and unitary operators-Projections. Algebras of operators.

Unit-V General Preliminaries on Banach Algebras: The definitions and some examples-Regular and singular elements-Topological divisors of zero-The spectrum-The formula for the spectral radius.

Books Recommended:

- 1.Introduction to Topology and Modern Analysis by **G.F.Simmons**, McGraw-Hill, New York, 1963.
- 2.A Course in Functional Analysis by **J. B. Conway**, Springer, New York, 1990.
3. First Course in Functional Analysis by **C. Goffman & G. Pedrick**, Prentice-Hall of India, New Delhi, 2002.
4. Elements of Functional Analysis by **L. A. Lusternik & V. J. Sobolev**, Hindustan Publishing Co, New Delhi, 1985.
5. Introduction to Functional Analysis by **A. E. Taylor**, John Wiley, New York, 1958.

LATEX & MATHEMATICA

THEORY

Total Marks: 100 (70+30)

Course Objective:- The main motive is to impart the knowledge and understanding about LaTeX and Mathematica system, explain the procedure of LaTeX typesetting and familiarize the participants with various document formats of LaTeX and enable them to prepare research articles, thesis, books, and presentations with confidence.

Students will be able to learn:

Course Outcomes:-



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CO-1 Typesetting of complex mathematical formulae using LaTeX.

CO-2 Use tabular and array environments within LaTeX.

CO-3 Use various methods to Mathematica.

CO-4 On completion of the course the students will get familiar Advanced Mathematics In Mathematica.

CO-5 On completion of the course the students will get familiar Linear algebra.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
LATEX & MATHEMATICA Subject code – MSCMODL304	CO 1 - Typesetting of complex mathematical formulae using LaTeX.	1,3,5,6,8	2,3
	CO 2 - Use tabular and array environments within LaTeX.	2,3,5,7	1,3
	CO 3 – Use various methods to Mathematica.	2,5,8,10	1,2,3
	CO 4 – On completion of the course the students will get familiar Advanced Mathematics In Mathematica	2,4,5,6,8,9	2,3
	CO 5 - On completion of the course the students will get familiar Linear algebra.	2,4,5,7,8	1,3

CO-PO and CO-PSO Mapping

Subject	LATEX & MATHEMATICA												
Code	MSCMODL304												
Course outcomes CO MSCMODL101	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO304.1	2	-	3	-	1	2	-	2	-	-	-	2	2
CO304.2	-	2	2	-	3	-	2	-	-	-	2	-	2
CO304.3	-	2	-	-	1	-	-	1	-	2	2	1	3
CO304.4	-	3	-	2	1	2	-	2	2	-	-	3	2
CO304.5	-	2	-	3	1	-	2	1	-	-	1	-	1

Note: 1- Low relation

2- Average relation

3- Good relation

Unit – I:

Special Characters, Document layout and organization– Document class, Page style, Parts of the document, Centering and indenting, Lists, Theorem–like declarations, Boxes, Tables.

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Unit – II:

Footnotes and marginal notes, Mathematical formulas – Mathematical environments, Main elements of math mode, Mathematical symbols, Additional elements, Fine-tuning mathematics, Drawing pictures with LATEX.

Unit – III:

Introduction To Mathematica: Running Mathematica - Numerical calculations – Building up calculations – Using the Mathematica system – Algebraic calculations - Symbolic mathematics - Numerical mathematics.

Unit – IV:

Advanced Mathematics In Mathematica: Numbers - Mathematical functions – Algebraic manipulation – Manipulating equations - Calculus.

Unit – V:

Series, limits and residues - Linear algebra.

Books Recommended:

1. A Guide to LATEX by **H. Kopka** and **P.W. Daly**, Third Edition, Addison – Wesley, London, 1999.
2. The Mathematica Book by **S. Wolfram**, Fourth Edition, Cambridge University Press, Cambridge, 1999

**LATEX & MATHEMATICA
PRACTICAL****Total Marks: 50 (35+15)****ELECTIVE III
THEORY****Total Marks: 100 (70+30)****GRAPH THEORY****Course Objectives:**

The objectives of this course are to provide an introduction to the language, methods and terminology of the subject and to emphasise on algorithmic and probabilistic approaches that have proved fruitful in modern graph theory.

Course Outcomes:

- CO-1 On completion of the course the students will get familiar with graphs; trees; paths; cycles;
- CO-2 On completion of the course the students will get familiar with vertex degree;
- CO-3 On completion of the course the students will get familiar with connectedness; bipartite graphs; complete graphs
- CO-4 On completion of the course the students will get familiar with subgraphs and
- CO-5 The techniques learnt in this course to be useful in other areas of mathematics.



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Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
GRAPH THEORY Subject code – MSCMODL 306	CO 1 - On completion of the course the students will get familiar with graphs; trees; paths; cycles;	2,3,5,6,8,9	1,3
	CO 2 - On completion of the course the students will get familiar with vertex degree;	1,3,5,8,9,10	1,2,3
	CO 3 – On completion of the course the students will get familiar with connectedness; bipartite graphs; complete graphs.	2,4,6,8,9	2,3
	CO 4 – On completion of the course the students will get familiar with sub graphs.	1,3,4,5,8,9	1,2
	CO 5 - The techniques learnt in this course to be useful in other areas of mathematics.	1,5,8,9	2,3

CO-PO and CO-PSO Mapping

Subject	GRAPH THEORY												
Code	MSCMODL306												
Course outcomes CO MSCMODL 306	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO306.1	-	2	1	-	2	3	-	3	2	-	2	-	2
CO306.2	2	-	2	-	3	-	-	3	2	2	2	3	3
CO306.3	-	2	-	3	-	2	-	3	2	-	-	2	2
CO306.4	2	-	2	2	3	-	-	-	2	2	-	2	2
CO306.5	2	-	-	-	2	-	-	3	2	-	-	2	3

Note: 1- Low relation

2- Average relation

3- Good relation

Unit - I

Definition and types of graphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Applications of graphs, operations on Graphs, Graph Representation, Isomorphism of Graphs.

Unit - II

Eulerian and Hamiltonian paths, Shortest Path in a Weighted Graph, The Travelling Sales person Problem, Planar

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Graphs, Detection of Planarity and Kuratowski Theorem, Graph Colouring.

Unit - III

Directed Graphs, Trees, Tree Terminology, Rooted Labeled Trees, Prefix Code, Binary Search Tree, Tree Traversal.

Unit - IV

Spanning Trees and Cut Sets, Minimum Spanning Trees, Kruskal Algorithm, Prim Algorithm, Decision Trees, Sorting Methods.

Unit - V

Coloring and covering of graphs, Chromatic Polynomial, chromatic partitioning, Dimmer problem, Dominating sets, Independent sets, Four colour conjecture.

Books Recommended:

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice –Hall of India Pvt. Ltd, 2004.
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. G. Chartrand and P. Zhang. Introduction to Graph Theory, Tata McGraw-Hill, 2006.
4. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, Fourth Edition, 1999.
5. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York, 2007.
6. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition, 2005.
7. C. L. Liu and D.P.Mohapatra, Elements of Discrete Mathematics- A Computer Oriented Approach, Tata McGraw-Hill, Fourth Edition.

NUMBER THEORY & CRYPTOGRAPHY

Course Objective(s): Number theory is one of the oldest branches of Mathematics. In this course we introduce the basic concepts of Number theory such as Divisibility, Congruences with Prime Modulus, Quadratic reciprocity and some functions of Number Theory.

Course Outcome(s): After completing this course, the student will be able to:

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
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NUMBER THEORY & CRYPTOGRAPHY Subject code – MSCMODL306	CO 1 - Understand the concepts of divisibility and Primes.	1,3,4,6,8	1,3
	CO 2 - Solve congruences.	3,6,8,9,10	2,3
	CO 3 – Describe Gauss’s Lemma, Quadratic reciprocity law.	4,6,8,9	1,3
	CO 4 – Discuss Cryptography and its applications.	2,4,5,6,8,9	1,2,3
	CO 5 - Study the various cryptanalysis.	3,5,6,7,8,9,10	2,3

CO-PO and CO-PSO Mapping

Subject	NUMBER THEORY & CRYPTOGRAPHY												
Code	MSCMODL306												
Course outcomes CO MSCMOD L306	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO306.1	2	-	1	2	-	3	-	2	-	-	2	-	3
CO306.2	-	-	2	-	-	3	-	1	1	2	-	2	1
CO306.3	-	-	-	2	-	3	-	3	2	-	2	-	1
CO306.4	-	2	-	2	1	2	-	3	2	-	2	3	2
CO306.5	-	-	2	-	2	3	1	2	3	2	-	2	2

Note: 1- Low relation

2- Average relation

3- Good relation

UNIT I

Introduction To Number Theory:

Time estimates for doing arithmetic - Divisibility and the Euclidean algorithm – Congruences - Modular exponentiation - Some applications to factoring.

UNIT II

Quadratics Residues And Reciprocity Finite Fields - Multiplicative generators – Uniqueness of fields with prime power elements - Quadratic residues and reciprocity.

UNIT III

Cryptosystems: Some simple crypto systems - Digraph transformations - Enciphering Matrices -

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Affine enciphering transformations RSA - Discrete Log - Diffie-Hellman key exchange - The Massey – Omura cryptosystem - Digital Signature standard -Computation of discrete log

UNIT IV

Primality And Factoring – I, Pseudoprimes - Strong pseudo primes - Solovay-Strassen Primality test – Miller - Rabin test - Rho method - Fermat factoring and factor bases - Quadratic sieve Method.

UNIT V

Primality And Factoring – II Elliptic Curves - Elliptic curve primality test - Elliptic Curve factoring - Pollard's $p-1$ method -Elliptic curve reduction modulo n - Lenstras Method.

Books Recommended:

1. Neal Koblitz, "A course in Number Theory and Cryptography", 2nd Edition, Springer-Verlag, 1994.
2. Menezes A, "Van Oorschot and Vanstone S.A, Hand book of Applied Cryptography", CRC Press, 1996

FOURTH SEMESTER

NONLINEAR DIFFERENTIAL EQUATION THEORY

Total Marks: 100 (70+30)

Course Objectives: It is often seen that mathematical models are formulated in terms of equations involving functions as well as their derivatives. Such equations are called differential equations. The course covers the understanding of non linear differential equations and their solutions with the initial and boundary conditions. The course also covers the Perturbation Methods, Linear systems and Stability.

Course Outcome(s): After completing this course, the student will be able to:

CO1 Obtain solutions of the First order systems in two variables and linearization.

CO2 Comprehend the Averaging Methods

CO3 Understand the concepts of Perturbation Methods: Outline of the direct method..

CO4 Analyze the Linear systems: Structure of solutions of the general linear system

CO5 Identify the Comparison theorem for the zero solutions of nearly-linear systems.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O	P.O	P.S.O.
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NONLINEAR DIFFERENTIAL EQUATION Subject code – MSCMODL401	CO 1 - Obtain solutions of the First order systems in two variables and linearization	2,3,5,6,8	1,2,3
	CO 2 - Comprehend the Averaging Methods	1,4,5,6,9,10	2,3
	CO 3 – Understand the concepts of Perturbation Methods: Outline of the direct method.	2,3,5,7,9	1,3
	CO 4 – Analyze the Linear systems: Structure of solutions of the general linear sy	3,5,6,7,8	2,3
	CO 5 - Identify the Comparison theorem for the zero solutions of nearly-linear systems	2,4,6,8,9	2,3

CO-PO and CO-PSO Mapping

Subject	NONLINEAR DIFFERENTIAL EQUATION												
Code	MSCMODL401												
Course outcomes CO MSCMODL401	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO401.1	-	2	1	-	2	2	-	3	-	-	2	2	3
CO401.2	2	-	-	2	1	2	-	-	2	2	-	2	1
CO401.3	-	2	3	-	2	-	2	-	3	-	2	-	3
CO401.4	-	-	2	-	2	3	1	2	-	-	-	2	2
CO401.5	-	2	-	2	-	1	-	1	2	-	-	2	2

Note: 1- Low relation
2- Average relation
3- Good relation

Unit-I:

First order systems in two variables and linearization: The general phase plane - Some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

Unit-II:

Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – Slowly varying amplitudes; Nearly periodic solutions - Periodic solutions: Harmonic balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

Unit-III:

Perturbation Methods: Outline of the direct method – Forced oscillations far from resonance- Forced oscillations



near resonance with weak excitation – Amplitude equation for undamped pendulum – Amplitude perturbation for the pendulum equation – Lindstedt's method – Forced oscillation of a self – excited equation – The Perturbation method and Fourier series.

Unit-IV:

Linear systems: Structure of solutions of the general linear system – Constant coefficient system – Periodic coefficients – Floquet theory – Wronskian.

Unit-V:

Stability: Poincare stability – Solutions, paths and norms – Liapunov stability- Stability of linear systems – Comparison theorem for the zero solutions of nearly-linear systems.

Books Recommended:

1. "Nonlinear Ordinary Differential Equations" by **D.W. Jordan and P. Smith**, Clarendon Press, Oxford, 1977.
2. "Differential Equations" by **G.F. Simmons**, Tata McGraw-Hill, New Delhi, 1979.
3. "Ordinary Differential Equations and Stability Theory" by **D.A. Sanchez**, Dover, New York, 1968.
4. "Notes on Nonlinear Systems" by **J.K. Aggarwal**, Van Nostrand, 1972.

**OPERATION RESEARCH
THEORY**

Total Marks: 100 (70+30)

Course Objective(s): In this course basic concepts of Operations Research such as Linear Programming Problem, Duality in Linear Programming, Transportation Problem, Assignment Problem and Queuing Theory are introduced.

Course Outcome(s): After completing this course, the student will be able to:

- CO1** Apply and solve the problems - Games Theory and Queuing Theory: Poison queuing system.
- CO2** Understand the concept of LPP by Simplex method, dual simplex method, Big M method and its different applications.
- CO3** Analyze Transportation problem and Assignment Problems: Hungarian Method for solution. Traveling-Salesman problems and different application in real life.
- CO4** Understand Integer Programming, Goal Programming, Dynamic Programming and its importance in optimization process.
- CO5** Discuss the Non-Linear Programming and its applications.



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Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O.
OPERATION RESEARCH Subject code – MSCMODL 402	CO 1 - Apply and solve the problems - Games Theory and Queuing Theory: Poison queuing system.	1,3,5,8,9	1,3
	CO 2 - Understand the concept of LPP by Simplex method, dual simplex method, Big M method and its different applications	2,3,5,6,7,8	1,2,3
	CO 3 - Analyze Transportation problem and Assignment Problems: Hungarian Method for solution. Traveling- Salesman problems and different application in real life.	2,3,5,6,8,9,10	1,2
	CO 4 - Understand Integer Programming, Goal Programming, Dynamic Programming and its importance in optimization process.	2,3,5,8,9	2,3
	CO 5 - Discuss the Non-Linear Programming and its applications	1,4,6,7,9,10	2,3

CO-PO and CO-PSO Mapping

Subject	OPERATION RESEARCH												
	MSCMODL 402												
Course outcomes CO MSCMOD L402	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO402.1	2	-	3	-	1	-	-	1	2	-	1	-	2
CO402.2	-	1	2	-	1	2	3	1	-	-	2	2	1
CO402.3	-	2	3	-	2	2	-	2	1	3	2	2	-
CO402.4	-	2	2	-	2	1	-	2	3	-	-	2	2
CO402.5	2	-	-	2	-	1	2	-	2	3	-	2	2

Note: 1- Low relation

2- Average relation

3- Good relation

Unit-I

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Introduction, Nature and Meaning of O.R. Modelling in operations Research, Features of Operation research, scope of operations research Linear Programming Problem: formulation of L.P.P. solution of L.P.P. Graphical Method, Simplex Methods in Duality, Integer Programming.

Unit-II

Assignment problems: Mathematical formulation, reduction theorem, unbalanced assignment problem, Transportation problem formulation, basic feasible solution – North-West-corner method, Least cost method, Vogel's Approximation method, Optimum solution: MODI method.

Unit-III

Job sequencing: Processing n jobs through 2 machines, Processing n jobs through 3 machines, Processing 2 Jobs through m machines, Replacement problems: Replacement policy for items whose maintenance cost increase with time and money value is constant, Money value changes with constant rate.

Unit-IV

Project management: Introduction, network diagram representation, time estimates and critical path with saddle point, rectangular game with out saddle point, Principle of dominance, Graphical method.

Unit-V

Queuing Theory: Introduction, queuing system Transient and steady traffic inlets, Distribution of arrival distribution of departure, M/M/I: ∞ / FCFS model nonlinear programming: Kuhn-Tucker conditions.

Books Recommended:

1. Linear Programming by G. Hadley, Narosa Publishing House, 1995.
2. Operations Research by R.K. Gupta.
3. Introduction to Operations Research (Sixth Edition) by F.S. Hillier and G.J. Lieberman Mc Graw Hill International Edition, Industrial Engineering Series, 1995.
4. Operations Research by S.D. Sharma.

FUZZY SETS THEORY THEORY

Total Marks: 100 (70+30)

Course Objective(s): To get the basic knowledge of Fuzzy Set and the applications and also the operations, norm of it is expressed.

Course Outcome(s): After completing this course, the student will be able to:



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CO 1 - Understand the concept of Fuzzy sets.

CO 2 - Express operations on fuzzy sets

CO 3 -Apply Relation between fuzzy sets and its compositions

CO 4 -State Fuzzy graphs.

CO 5 - Express the Fuzzy measures

Skills that students will obtain after completion of the course:

COURSE NAME	C.O.	P.O.	P.S.O
FUZZY SETS THEORY Subject code – MSCMODL 403	CO 1 - Understand the concept of Fuzzy sets.	1,4,6,8,9	2,3
	CO 2 - Express operations on fuzzy sets	2,4,5,8,9	1,3
	CO 3 -Apply Relation between fuzzy sets and its compositions	1,3,5,6,8,	1,3
	CO 4 – State Fuzzy graphs.	2,4,5,8,9,10	1,2,3
	CO 5 - Express the Fuzzy measures	2,4,5,7,8	1,2

CO-PO and CO-PSO Mapping

Subject Code	FUZZY SETS THEORY												
	MSCMODL 403												
Course outcomes CO MSCMOD L101	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO403.1	2	-	-	2	-	1	-	1	2	-	-	2	2
CO403.2	-	2	-	3	2	-	-	2	1	-	2	-	3
CO403.3	2	-	2	-	1	1	-	3	-	-	1	-	2
CO403.4	-	2	-	2	1	-	-	2	3	3	1	1	2
CO403.5	-	2	-	3	2	-	3	2	-	-	2	2	-

Note: 1- Low relation

2- Average relation

3- Good relation

Unit- I

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Fuzzy Sets-Basic definitions, α -level sets, convex fuzzy sets, Basic operations on fuzzy sets Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and difference, t - Norms and t - co norms.

Unit-II

The Extension Principle – The Zadeh's extension principle, Image and inverse image of fuzzy sets, Fuzzy numbers, Elements of fuzzy arithmetic.

Unit-III

Fuzzy Relation and Fuzzy Graphs-Fuzzy relation on fuzzy sets, Composition of fuzzy relations, Min-Max composition and its properties, Fuzzy equivalence relation, Fuzzy compatibility relations, Fuzzy relation equations, Fuzzy graphs, Similarity relation.

Unit-IV

Possibility Theory-Fuzzy measures, Evidence theory, Necessity measure, Possibility measure, Possibility distribution, Possibility theory and fuzzy sets, Possibility theory versus probability theory

Unit-V

Fuzzy Logic-An overview of classical logic, Multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic variables and hedges, Inference from conditional fuzzy propositions, the compositional rule of inference.

Books Recommended:

1. Fuzzy set theory and its Applications by H.J. Zimmermann, Allied Publishers Ltd., New Delhi, 1991.
2. Fuzzy sets and Fuzzy logic by G.J. Klir and B. Yuan Prentice-Hall of India, New Delhi, 1995.
3. Fuzzy Sets, Uncertainty and Information by G.J.Klir, Tina A. Folger Prentice-Hall of India.

ELECTIVE 4

THEORY

Total Marks: 100 (70+30)

APPROXIMATION THEORY

Course Objective(s): Approximation theory is one of the oldest branches of Mathematics. In this course we introduce the basic concepts of Approximation theory In Normed Linear Spaces, Chebyshev Polynomials, Interpolation, Best Approximation In Normed Linear Spaces and some Projection.

Skills that students will obtain after completion of the course:



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COURSE NAME	C.O.	P.O.	P.S.O
APPROXIMATION THEORY Subject code – MSCMODL404	CO 1 - Understand the concepts of Approximation In Normed Linear Spaces.	2,4,5,6,8,10	2,3
	CO 2 - Solve Chebyshev Polynomials.	1,3,5,6,8,9	1,3
	CO 3 – Describe Interpolation.	1,3,5,7,9	1,3
	CO 4 – Discuss Best Approximation In Normed Linear Spaces.	2,4,6,8,9	2,3
	CO 5 - Study the various Projection.	2,4,5,7,8,10	1,2,3

CO-PO and CO-PSO Mapping

Subject	APPROXIMATION THEORY												
Code	MSCMODL 404												
Course outcomes CO MSCMOD L404	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO404. 1	-	2	-	2	3	1	-	2	-	3	-	2	2
CO404. 2	2	-	3	-	2	1	-	1	2	-	2	-	3
CO404. 3	2	-	3	-	2	-	1	-	3	-	2	-	2
CO404.4	-	2	-	3	-	1	-	2	1	-	-	2	1
CO404.5	-	2	-	3	2	-	1	2	-	3	2	3	2

Note: 1- Low relation

2- Average relation

3- Good relation

UNIT I

Approximation In Normed Linear Spaces: Existence- Uniqueness – convexity – Characterization of best uniform approximations –Uniqueness results – Haar subspaces – Approximation of real valued functions on an interval.

UNIT II

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Chebyshev Polynomials: Properties – More on external properties of Chebyshev polynomials – Strong uniqueness and continuity of metric projection – Discretization – Discrete best approximation.

UNIT III

Interpolation: Introduction – Algebraic formulation of finite interpolation – Lagrange’s form –extended Haar subspaces and Hermite interpolation – Hermite – Fejer interpolation.

UNIT IV

Best Approximation In Normed Linear Spaces: Introduction – Approximative properties of sets – Characterization and Duality.

UNIT V Projection Continuity of metric projections – Convexity, Solarity and Cheyshevity of sets – Best simultaneous approximation.

Books Recommended:

1. Hrushikesh N. Mhaskar and Devidas V. Pai., “Fundamentals of approximation theory”, Narosa Publishing House, New Delhi, 2000.
2. Ward Cheney and Will light, “A course in approximation theory”, Brooks / Cole Publishing Company, New York, 2000.
3. Cheney E.W.,”Introduction to approximation theory”, McGraw Hill, New York, 1966.
4. Singer I.,”Best Approximation in Normed Linear Spaces by element of linear subspaces”, Springer-Verlag, Berlin ,1970

MATHEMATICAL MODELING

Course Objective(s): This course gives the basic concept of Mathematical modelling, so that students from various fields like Engineering, Economics, Biology, Epidemiology etc. can apply its concept.

Course Outcomes: After completion of this course, the student will be able to:

CO 1 - Discuss the basic features of mathematical modelling.
CO 2 - Apply the mathematical modeling using ODE of first order.
CO 3 – Explain the discrete model and its applications.
CO 4 – Get the application of continuous and spatial models
CO 5 - Use the modelling using graph theory.

Skills that students will obtain after completion of the course:

COURSE NAME	C.O	P.O.	P.S O
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MATHEMATICAL MODELING Subject code – MSCMODL404	CO 1 - Discuss the basic features of mathematical modelling.	1,2,3,7,8	2,3
	CO 2 - Apply the mathematical modeling using ODE of first order.	2,3,4,5,6,10	1,3
	CO 3 – Explain the discrete model and its applications.	4,5,8,9	2,3
	CO 4 – Get the application of continuous and spatial models	4,8,9,10	1,2,3
	CO 5 - Use the modelling using graph theory.	2,5,8,9	2,3

CO-PO and CO-PSO Mapping

Subject	MATHEMATICAL MODELING												
Code	MSCMODL404												
Course outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
MSCMODL404			3	4	5	6	7	8	9	10	1	2	3
CO404.1	2	2	1	-	-	-	3	3	-	-	-	3	2
CO404.2	-	2	3	2	1	2	-	3	-	-	2	-	3
CO404.3	-	-	-	2	3	-	-	2	3	-	-	2	2
CO404.4	-	-	-	3	-	-	-	3	2	1	2	2	1
CO404.5	-	2	-	-	2	-	-	3	2	-	-	2	3

- Note:**
- 1- Low relation
 - 2- Average relation
 - 3- Good relation

Unit - I

Techniques, classification and simple illustrations. Mathematical Modelling through ordinary differential equation of first order.

Unit – II

Mathematical Modelling through systems of ordinary differential equation of first order. Mathematical Modelling through ordinary differential equation of second order.




Unit - III

Mathematical Modelling through difference equation. Mathematical Modelling through partial differential equations.

Unit - IV

Mathematical Modelling through graphs. Mathematical Modelling through functional Integral, Delay-differential.

Unit - V

Mathematical Modelling through calculus of variations and dynamic programming. Mathematical Modelling through mathematical programming, maximum principle and maximum entropy principle.

Books Recommended:

1. J.N. Kapur, Mathematical Modeling, New Age International Limited.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd.
3. Mathematical Models in the Social, Management and Life Sciences, D.N. Burghes and A.D. Wood, John Wiley & Sons.
4. Mathematical Modeling, J.G. Andrews & R.R. McIone, Butterworths (Pub.) Inc
5. Mathematical Modelling : Dr. Maurya Navkar pub. Ajmer

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Duration of the Programme:

The minimum duration of the programme is 02 years and maximum duration is 04 years.

Medium of the Programme:

English is the medium of the programme and examination may be written in English or Hindi as per the learner's choice of the medium.

Requirement of Faculty and Supporting Staff:

Supporting staff will be deputed at the learner supported Centre as per the need of course curriculum.

Category	Existing
Professor	01
Associate Professor	01
Assistant Professor	00

Instructional Delivery Mechanism and Usage of Media:

As the programme will offer in MATS Centre of Open and Distance Education mode, there are various instructional delivery mechanisms and media will be used to effectively deliver content to the learners. The programme delivery mechanism used by MCDOE follows a multimedia approach for instructions, which are as follows:

- The printed self-learning material (SLM) which covers all the metrics of the programme will be delivered to the learners for every course.
- Learning Management System (LMS) is an online platform that provides a centralized location for students to access learning content, engage in discussions, submit assignments, and take assessments. The LMS provides a user-friendly interface that is accessible on multiple devices, such as desktops, laptops, tablets, and smartphones.
- Webinars can be used for lectures, discussions, or interactive sessions with students. Pre-recorded video lectures can be used to deliver course content in a concise and engaging way. Interactive multimedia includes simulations, games, and quizzes that are designed to reinforce learning.
- Discussion forums can be used to facilitate group discussions, peer-to-

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peer learning, and to provide feedback and support. Online and face-to-face counselling will be provided by academic counsellors appointed for the programme.

- The counseling sessions are held as per schedule drawn by the MCDOE. These counselling sessions are held in non-working hours for the learners so they can attend the counselling session properly and regularly to enhance their learning skills.
- Live session will be conducted through the use of Internet Communication Technologies (ICT) from the University's studio, the schedule of which is made available at the Learner Support System.
- Programmes which have industrial training/practical/ project component are held at University's learners support centers and Attendance of the learner in this part of the courses is compulsory. As per guidelines Project Work of the programme will be done by the learners and regarding this a complete guide will be deliver to the learner along with study material.
- The SLM will be dispatched periodically to the enrolled learners for each course of the programme. These SLM's will be very helpful to the learners in effective learning. The assignment for internal assessment of learner's shall be deliver to the learners along with the SLM. Online modules are also available in the University's website for some programme.
- The contact classes and counselling schedule will be of 30 days in a year which will be divided as 15 days in each semester. The schedule of contact classes of the programme shall be communicated to the student through the various medium.

Learner Support Services:

MATS Centre for Open and Distance Education has a fully-fledged Learner Support Services to provide guidance and help to its learners. All the necessary information has been provided to all the learner via various medium like website, helpdesk, email and by person-to-person interaction via teleconferencing and calling.



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Learning Management System (LMS) to Support Course Delivery for ODL Mode:

The Learning Management System (LMS) is designed to facilitate the students to have a Global learning experience. LMS has user friendly interface approach through which the learning is made easy, interesting and meeting the global standards of learning. The audio-visual mode of teaching, the self-learning materials, discussion forums and evaluation patterns are unique and meeting the requirements of the industry and as per UGC guidelines of four quadrants approach.

The students can experience uninterrupted learning 24x7 through web and mobile at the pace chosen by them. The user interface will be simple and easy to navigate through the e-learning modules; the LMS will provide seamless accessibility with all the learning tools designed as per standard norms for an easy and interesting learning experience.

Nature of Contact Classes:

Based on the course material, the counsellors for Distance Education, are expected to guide and talk with the learners during the contact class sessions. By talking with their coworkers and the counsellor during contact sessions in online mode, the learners can work through their problems and this will help them to understand the programme objectives to learn with ease. In addition to these online contact sessions, learners must participate in various training programmes run by the relevant learner support system provided by the University which also including practical training approach as per Programme's structure.

Counseling Session & Structure of Study in ODL Mode:

Delivery in ODL Mode: Following is the study structure of the programme:

Counseling Sessions Study Structure (In Hours)								
Semester I : Subject Code	Name of Subject	Credit Theory/Practical	Total Hours of Study	Face to Face Counseling	Self- Study	Practi- cal Work	Assi- gn- ments	Project / Dissertation
MSCMODL101	ALGEBRA	4	120	16	68	-	36	
MSCMODL102	REAL ANALYSIS	4	120	16	68	-	36	
MSCMODL103	DIFFERENTIAL EQUATIONS	4	120	16	68	-	36	
MSCMODL104	DISCRETE MATHEMATICS	4	120	16	68	-	36	
MSCMODL105	ELECTIVE I	4	120	16	68	-	36	

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Semester II : Subject Code	Name of Subject	Credit Theory/Practical	Total Hours of Study	Face to Face Counseling	Self- Study	Practi- cal Work	Assi- gn- ments	Project / Dissertation
MSCMODL201	COMPLEX ANALYSIS	4	120	16	68	-	36	
MSCMODL202	PARTIAL DIFFERENTIAL EQUATIONS	4	120	16	68	-	36	
MSCMODL203	LINEAR ALGEBRA	4	120	16	68	-	36	
MSCMODL204	MATLAB	3	90	10	10	30	40	
MSCMODL205	MATLAB	2	60	8	22		30	
MSCMODL206	ELECTIVE 2	4	120	16	68	-	36	
Semester III: Subject Code	Name of Subject	Credit Theory/Practical	Total Hours of Study	Face to Face Counseling	Self- Study	Practi- cal Work	Assi- gn- ments	Project / Dissertation
MSCMODL301	TOPOLOGY	4	120	16	68	-	36	
MSCMODL302	MATHEMATICAL METHODS	4	120	16	68	-	36	
MSCMODL303	FUNCTIONAL ANALYSIS	4	120	16	68	-	36	
MSCMODL304	LATEX & MATHEMATICA	3	90	16	44		30	
MSCMODL305	LATEX & MATHEMATICA	2	60	8	22		30	
MSCMODL306	ELECTIVE 3	4	120	16	68	-	36	
Semester IV: Subject Code	Name of Subject	Credit Theory/Practical	Total Hours of Study	Face to Face Counseling	Self- Study	Practi- cal Work	Assi- gn- ments	Project / Dissertation
MSCMODL401	NONLINEAR DIFFERENTIAL EQUATION	4	120	16	68	-	36	
MSCMODL402	OPERATION RESEARCH	4	120	16	68	-	36	
MSCMODL403	FUZZY SETS THEORY	4	120	16	68	-	36	
MSCMODL404	ELECTIVE 4	4	120	16	68	-	36	
MSCMODL405	PROJECT/DISSERTATI ON	6	180	8	22	-		150

Procedure for Admission, Curriculum Transaction and

Evaluation:

Candidate to be eligible for admission to the M.Sc. Mathematics program in MATS Open and Distance Education mode, candidates must possess a bachelor's degree or an equivalent certification from an accredited university. M.Sc. Mathematics applicants can conveniently access all admission-related information, including the application



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process, through the University's website or by contacting the helpdesk. The admission form can be downloaded from the website and submitted via online or offline mode. Upon receipt, the University will review the documents and process the fee payment. Once the payment is completed, the admission will be confirmed, and an enrollment number will be issued to the student.

■ Fee Structure:

The fee structure of the programme in ODL mode is as follows:

Programme	Semester Tuition Fees	Semester Examination Fees	Registration Fees (One Time)
M. Sc. Mathematics	10000	1500	1000

Examination and Evaluation System:

Evaluation shall be based on continuous assessment, in which sessional work and the terminal examination shall contribute to the final grade. Sessional work shall consist of class tests, mid-semester examination(s), homework assignments, etc., as determined by the faculty in charge of the courses of study. Progress towards achievement of learning outcomes shall be assessed using the following: time-constrained examinations; closed-book and open-book tests; problem-based assignments; practical assignment laboratory reports; observation of practical skills; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerized adaptive assessment, examination on demand, modular certifications, etc. Each course shall correspond to an examination paper comprising of external and internal evaluations.

The semester end theory examinations for Major, Minor, Open/Generic and DSC (Discipline specific Course) vocational, value added, SEC (Skill Enhancement Course) and AEC (Ability Enhancement Course) shall be of a duration as promulgated through the examination's regulations approved by the Academic Council of the University. The credit structure for theory/Practical/tutorial, internal, external examinations and total marks for an examination shall be as per the programme structure approved by the Academic Council of the University as per UGC norms. Students shall acquire a minimum passing mark in internal and external examinations separately to be declared as pass in the respective courses, as prescribed by the Academic Council.



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1. The academic performance of a candidate shall be evaluated in respect of
2. The courses of study prescribed for each semester through the evaluation. The evaluation of students admitted in the programme shall be based on:
 - 2.1. End Semester Examinations - 70% marks of total marks and
 - 2.2. Continuous Internal Assessment - 30% of total marks
3. The End Semester examinations shall be held as per the academic calendar notified by the University and the duration of end semester examination shall be of three or two hours.
4. The minimum percentage of marks to pass the programme in each semester shall be 40% in each course comprising of end semester examinations and continuous evaluation.
5. A programme shall have a specified number of credits in each semester. The number of credits along with grade points that the student has satisfactorily cleared shall measure the performance of the student.
6. Semester examination results shall have following categories:
 - 6.1. Passed, i.e., those who have passed in all courses of the semester examination in internal and external examination separately.
 - 6.2. Promoted (ATKT), i.e., those who have earned minimum 50% of credits in a particular year including both the semesters (even and odd) or those who have earned any number of credits in odd semester.
 - 6.3. Detained, i.e., those who are not promoted as per the above provisions shall be detained. Such students have to appear in the examination of next academic session to earn required credits (excluding the credits already earned) as per the provisions of this ordinance and only then he/she may continue the programme within stipulated period as per the provisions of this ordinance.

However, a student of any semester who has been detained/ not appeared in examination due to less attendance/ not applied for examination/ applied but not appeared shall be out from the programme. Such a student has to take admission in the next session as an ex-student through the procedure adopted/notified by the University.

Continuous Internal Assessment:

1. Continuous Internal Assessment shall be of 30% marks of total marks allotted for the course.
2. The components for continuous internal assessment for each course shall be decided



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by the Board of Studies of concerned subject.

3. Continuous Internal assessment shall be carried forward in case of ATKT students, there shall not be any provision of conducting internal assessment tests for ATKT students at any circumstances.
4. Evaluation and Certification of MOOCs and Vocational Courses: The guidelines of the University/SWAYAM portal/UGC shall be followed for evaluation and certification of MOOCs, Vocational Courses, Field Projects/ Internship/ Apprenticeship/ Community engagement and service/ Honours with Research Project.

Letter Grades and Grades Point:

The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester. The SGPA is based on the grades of the current term, while the Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.

The University may also mention marks obtained in each course and a weighted average of marks based on marks obtained in all the semesters taken together for the benefit of students.

Grading System

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	>90 to <=100
A+	9	Excellent	>80 to <=90
A	8	Very Good	>70 to <=80
B+	7	Good	>60 to <=70
B	6	Above Average	>50 to <=60
C	5	Average	>40 to <=50
P	4	Pass	=40
F	0	Fail	<40
Ab	0	Absent	Absent

Computation of SGPA and CGPA:

UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

- I. The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.



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$$SGPA (S_i) = \sum (C_i \times G_i) / \sum C_i$$

Where C_i is the number of credits of the i th course and G_i is the grade point scored by the learner in the i th course.

Example of Computation of SGPA

Semester	Course	Credit	Letter Grade	Grade point	(Credit x Grade)
1	Course 1	3	A	8	3 x 8 = 24
1	Course 1	4	B +	7	4 x 7 = 28
1	Course 1	3	B	6	3 x 6 = 18
1	Course 1	3	O	10	3 x 10 = 30
1	Course 1	3	C	5	3 x 5 = 15
1	Course 1	4	B	6	4 x 6 = 24
		20			139
SGPA					139/20=6.95

- II. The Cumulative Grade Point Average (CGPA) is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum (C_i \times S_i) / \sum C_i$$

where S_i is the SGPA of the i th semester and C_i is the total number of credits in that semester.

Example of Computation of CGPA

Semester 1	Semester 2	Semester 3	Semester 4
Credit 20	Credit 20	Credit 20	Credit 20
SGPA 6.9	SGPA 7.8	SGPA 5.6	SGPA 6.0
CGPA = (20 x 6.9 + 20 x 7.8 + 20 x 5.6 + 20 x 6.0)/80 = 6.6			

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts. On completing all requirements for the award of the undergraduate certificate/ diploma/ degree, the CGPA shall be calculated, and this value shall be indicated on the certificate /diploma/degree. The 3-years (6 semester) and 4-years (8 semester) undergraduate degrees should also indicate the Division obtained as per following Table:

Division	Criterion
First division with distinction	The candidate has earned minimum number of credits for the award of the degree with CGPA of 7.5 or above



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First division	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 6.0 above but less than 7.5
Second division	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 4.5 or above but less than 6.0
Third Division	The candidate has earned minimum number of credits required for the award of the degree with CGPA of 4.00 or above but less than 4.5

- **Note:** The conversion of CGPA into percentage shall be as followed to facilitate its application in other academic matters.

Equivalent Percentage = $CGPA \times 10$. The percentage shall be rounded off up to the second decimal point.

The candidate shall be awarded a certificate/diploma/degree when he/she successfully earns the minimum required credits for the certificate/diploma/degree.

- **Issue of Transcript:**

Based on the recommendations on Letter grades, grade points and SGPA and CGPA, the university shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

- **Credit Transfer:**

1. The credit transfer shall be implemented as per the policy of the University framed in accordance with the guidelines issued by the UGC from time to time.
2. The member institutions of the Academic Bank of Credit established vide University Grants Commission (Establishment and Operation of Academic Bank of Credits in Higher Education) Regulations 2021 shall accept and transfer the credits as per the provisions of this regulation as amended from time to time.
3. Except for the cases of provisional promotions, the university shall facilitate credit transfer of students between them however, the student may be required to fulfil some eligibility criteria, drawing parity for a course, framed by the University in which the student seeks admission.
- 4.

Requirement of the Laboratory Support and Library Resource:

In open and distance learning M.Sc. Mathematics programme, laboratory support will

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be provided through various means such as virtual labs, cloud-based labs, or remote access to physical labs. Simulations and virtual labs will be used to provide students with a virtual environment in which they can perform practical tasks. In some cases, it may be possible to provide students with remote access to physical labs. Moreover, Instructors will record practical demonstrations and provide students with access to these videos. Students can watch these videos and practice the tasks on their own computers. Instructors will use video conferencing tools to demonstrate practical tasks and answer students' questions.

Cost Estimates of the Programme and the Provision:

This programme was already designed and developed in the conventional mode. In this process of overall development according to the current scenario, the cost estimate of all the metrics, components, equipment, advanced lab & maintenance cost for this programme comes to amount of Rs. 2380000 and provision is made of Rs. 2400000.

Quality Assurance Mechanism and Expected Programme

Outcomes:

The programme structure of the open distance learning M.Sc. Mathematics programme is designed under the guidance of an expert committee, the Board of Studies, and the Faculty Board. It is developed in accordance with the guidelines of statutory bodies and is approved by the Board of Studies, Faculty Board, and Academic Council of the University. The curriculum is reviewed annually to align with the evolving needs of the industry and research activities. Any necessary updates and improvements are forwarded to the Board of Studies, Faculty Board, and Academic Council for approval. The changes in the course curriculum as per the needs and requirements from time to time. The University will help the passed-out students in their placement in different industries through the training and placement cell.

Expected Outcomes of the Programme:

- Learners will be able to gain fundamental knowledge of skills.
- Learners will be able to apply knowledge, concepts to solve issues related to their course.
- Solve problems through analytical thinking.
- Apply knowledge of mathematics to solve various real-life problems.
- Formulate mathematical models to interpret and analyze data for interdisciplinary research and development.



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- Solve various mathematical problems by using relevant mathematical and statistical software.
- Exhibit strong ethical and professional sensibility.
- Graduate holders will have the knowledge for the need of sustainable development.
- Graduate holders will have the knowledge of ethics and regulatory norms of their respective course.
- The Learners will get wide range of Mathematical skills, including problem-solving, project work and presentation; they may enable to take prominent roles in a wide spectrum of employment in academics and research.
- Get a strong knowledge in mathematical sciences which include courses from Mathematics.
- Select a successful career in the sectors such as teaching, research, banking, planning and higher education, administrative service and for the advance study.
- Exhibit professionalism, ethics, communication skills, team work in their profession and adapt to current scenario by engaging in lifelong learning for the service of the society.



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