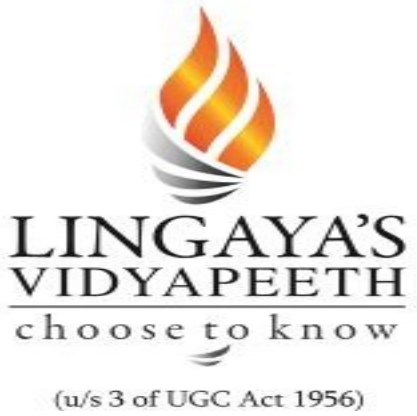
LINGAYA'S VIDYAPEETH

FARIDABAD



SYLLABUS

MASTER OF SCIENCE- MATHEMATICS

(TWO YEAR FULL TIME PROGRAMME)

(FOUR SEMESTER COURSE)

Department of Mathematics

School of Basic & Applied Science

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGS, MHRD, AICTE, BCI, PCI & ACI)

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)
Theory Courses

Sub-component	**Weightage**
MID-Semester Examination	**15**
Assignment/Quiz/Tutorial/Viva-voce (**ABQ)**	**25**
End-Semester Examination	**60**

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PROGRAMME STRUCTURE
M.Sc. Mathematics

School : School of Basic and Applied Sciences	**Batch: 2022-2024**
Department: Mathematics	**Year: 2022**
Course: M.Sc. Mathematics	**Semester: 1ST**

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	**MMA-101**	**Abstract Algebra**	4	0	0	4	15	25	60	-	-	100
2	PCC	**MMA-103**	**Fluid Dynamics**	4	0	0	4	15	25	60	-	-	100
3	PCC	**MMA-105**	**Operations Research**	4	0	0	4	15	25	60	-	-	100
4	PCC	**MMA-107**	**Complex Analysis**	4	0	0	4	15	25	60	-	-	100
5	PCC	**MMA-109**	**Ordinary Differential Equation**	4	0	0	4	15	25	60	-	-	100
			Total---->	**20**	**0**	**0**	**20**						**500**

Abbreviations:

PCC:	Programme Core Courses	ABQ:	Assignment Based Quiz
PEC:	Programme Elective Courses	MSE:	Mid Semester Examination
PROJ:	Project	ESE:	End Semester Examination
PDP:	Personality Development Programme	IP:	Internal Practical
L:	Lecture	EXP:	External Practical
T:	Tutorial		
P:	Practical		

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School : School of Basic and Applied Sciences	Batch: 2022-2024
Department: Mathematics	Year: 2023
Course: M.Sc. Mathematics	Semester: 2nd

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	**MMA-102**	**Linear Algebra**	4	0	0	4	15	25	60	-	-	100
2	PCC	**MMA-104**	**Functional Analysis**	4	0	0	4	15	25	60	-	-	100
3	PCC	**MMA-106**	**Numerical Analysis**	4	0	0	4	15	25	60	-	-	100
4	PCC	**MMA-108**	**Partial Differential Equation**	4	0	0	4	15	25	60	-	-	100
5	PCC	**MMA-110**	**Calculus of variations**	4	0	0	4	15	25	60	-	-	100
			Total---->	**20**	**0**	**0**	**20**						**500**

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School : School of Basic and Applied Sciences	**Batch: 2022-2024**
Department: Mathematics	**Year: 2023**
Course: M.Sc Mathematics	**Semester: 3rd**

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	**MMA-201**	**Topology**	4	0	0	4	15	25	60	-	-	100
2	PCC	**MMA –203**	**Measure And Integration**	4	0	0	4	15	25	60	-	-	100
3	PCC	**MMA -205**	**Probability and Statistics**	4	0	0	4	15	25	60	-	-	100
4	PCC	**MMA –207**	**Special Paper (Anyone)** **(I)** Classical Mechanics **(II)** Advanced Discrete Mathematics **(III)** Mathematical Modeling **(IV)** Theory of Field Extensions	4	0	0	4	15	25	60	-	-	100
5	PCC	**MMA –209**	**Special Paper (Anyone)** **(I)** Special Function **(II)** Fuzzy Sets and Applications **(III)** Mechanics of Solids **(IV)** Multivariate Analysis	4	0	0	4	15	25	60	-	-	100
6	PEC	**MMA –251**	**MATLAB**	0	0	2	1				40	60	100
7	Proj	**MMA –253**	**Synopsis Seminar**	0	0	1	1				40	60	100
8	Proj	**MMA -255**	**Dissertation (**Literature Search and Review; Synopsis Submission**)**	0	0	4	2				40	60	100
			Total---->	**20**	**0**	**0**	**20**						**500**

School : School of Basic and Applied Sciences	**Batch: 2022-2024**
Department: Mathematics	**Year: 2024**
Course: M.Sc Mathematics	**Semester: 4th**

SN	**Cate-gory**	**Course Code**	**Course Name**	**Periods**			**Credits**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**ABQ**	**MSE**	**ESE**	**IP**	**EXP**	
1	PCC	**MMA–202**	**Differential Geometry**	4	0	0	4	15	25	60	-	-	100
2	PCC	**MMA–204**	**Integral Equations & Boundary Value Problems**	4	0	0	4	15	25	60	-	-	100
3	PCC	**MMA-206**	**Research Methodology**	4	0	0	4	15	25	60	-	-	100
4	PCC	**MMA–252**	**Dissertation (Literature Search and Review; Thesis Submission)**	0	0	15	8				40	60	100
			Total---->	**16**	**0**	**15**	**24**						**400**

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SEMESTER-I

SCHOOL OF BASIC & APPLIED SCIENCES (DEPARTMENT OF MATHEMATICS)

Course code	Course subject	L	T	P	Credits
MMA- 101	**ABSTRACT ALGEBRA**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in algebra.

LEARNING OUTCOMES:
4. Use group in solving physical problems.
5. Use ring functions.
6. Use polynomials and other special functions.
7. Use homomorphism and isomorphism.

Unit	Contents	Lectures
I	Groups, subgroups, normal subgroups, quotient groups, Homomorphisms, cyclic groups, permutation groups, Even and odd. Cauchy's theorem for finite abelian and non-abelian groups, Sylow's theorems.	11
II	Sylow theorems and their applications, Finite Simple groups Survey of some finite groups, Groups of order p2 , pq (p and q primes).The normal series and composition series, Jordon-Holder theorem, Solvable groups, External and internal direct products.	13
III	Ring Theory: Review of Rings, Zero Divisors, Nilpotent Elements and idempotents, Matrices, Ring of endomorphisms, Ideals, Maximal and prime ideals, Nilpotent and nil ideals, Zorn's Lemma.Ideals.	11
IV	Principal ideals, Quotient rings, Field of quotients, embedding of rings, fundamental theorem on homomorphism and isomorphism.	8

TEXTBOOKS/REFERENCE BOOKS

1. Contemporary Abstract Algebra : Josheph A Gallian

2. A First course in Abstract Algebra : John. B. Fraleigh

3. Modern Algebra : Surject Singh and Quazi Jameerudin

4. Topics in Algebra : I. N. Herstein

5. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. III-Modules, Narosa Publishing House (Vol. I – 2013, Vol. III –2013).

6. Charles Lanski, Concepts in Abstract Algebra, American Mathematical Society, First Indian Edition, 2010.

7. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999. 4. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.

8. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.

9. C. Musili, Introduction to Rings and Modules, Narosa Publication House, 1994.

10. N. Jacobson, Basic Algebra, Vol. I & II, W.H Freeman, 1980 (also published by Hindustan Publishing Company).

11. M. Artin, Algebra, Prentice-Hall of India, 1991. 9. Ian D. Macdonald, The Theory of Groups, Clarendon Press, 1968

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Course code	Course subject	L	T	P	Credits
MMA- 103	**FLUID DYNAMICS**	4	0	0	4

LEARNING OBJECTIVES:
To demonstrate knowledge and understanding of the following fundamental concepts in:
The dynamics of system of particles, motion of fluid, Lagrangian and Eulerian methods.

LEARNING OUTCOMES:
1. Use a standard process for analyzing static objects.
2. Add forces and moments in two and three dimensions and find a component of a force or moment in each direction.
3. Describe types of fluids and their associated equations.
4. Use various kind of motions.

Unit	Contents	Lectures
I	Kinematics of fluids, Real fluids and ideal fluids, velocity of fluid at a point, streamlines, path lines, streak lines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrigational and rotational motion, acceleration of fluid, conditions at rigid boundary. Lagrangian and Eulerian methods.	13
II	Equation of motion of inviscid fluids, Euler's equation of motion, Bernouille's equation, Lanrage's equation, Conservative field of force, Cauchy's Integral, Helmholt's equation.	9
III	Impulsive motion, of a fluid, Energy equation of inviscid fluid, General theory of irrotational motion; connectivity, Flow and circulation, Kelvin's circulation theorem, Stoke's theorem, Permanence of irrotational motions.	10
IV	Green's theorem, Kinetic energy of finite and infinite liquid, Kelvin's minimum energy theorem, Mean value of the velocity potential over a spherical surface.	9
V	Motion in two dimention; Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and circle, Milne-Circle theorem.	11

TEXT BOOKS/REFERENCE BOOKS:
1. Foundation to Fluid Mechanics : S.W. Yuan
2. Text book of Fluid Dynamics : F. Chorltron
3. Theoretical Hydro-Dynamics : Bansi Lal
4. A text book of Fluid – Dynamics: M. Ray & Sharma

Course code	Course subject	L	T	P	Credits
MMA- 105	**OPERATIONS RESEARCH**	4	0	0	4

LEARNING OBJECTIVES:
Connect the solving method with previous knowledge.

LEARNING OUTCOMES:
4. Understand and explain the differences between linear programming and transportation problem.
5. Understand the Mathematical formulation.
6. Solve Queuing Models.
7. Spot, identify and relate the Non-Linear Programming Problems.

Unit	Contents	Lectures
I	Operation research: an introduction, Methodology of O.R. Features of O.R. Problems, Applications of O.R. Models Opportunities and shortcomings of O.R. Approach.	8
II	Linear Programming Problem (LPP): Formulation and examples, Feasible, Basic feasible and optimal solutions, Extreme points. Graphical Methods to solve L.P.P., Simplex Method, Charnes Big M Method, Two phase Method, Degeneracy, Duality theory, Dual LPP, fundamental properties of Dual problems, Complementary slackness, Dual simplex algorithm, Revised simplex method, Sensivity analysis.	12
III	Transportation Problem(TP): Mathematical formulation, Basic feasible solutions of T.Ps by North -West corner method, Row minima method, column minima method, least cost-Method, Vogel's approximation method. Unbalanced TP, optimality test of Basic Feasible Solution (BFS) by UV method (modified distribution method), Stepping Stone method, degeneracy in TP.	10
IV	Assignment Problem (AP): Mathematical formulation, assignment methods, Hungarian method, Unbalanced AP. Queuing Models: Queuing theory, Symbols and notations, Classification of queue, M/M/I queuing models.	9
V	Game theory: Two-person, zero-sum games, the maximin – minimax principle, pure strategies, mixed strategies, Graphical solution of 2xn and mx2 games, Dominance property, General solution of m x n rectangular games. Non-Linear Programming Problems (NLPP): Formulation of a NLPP, General non-linear NLPP, Constrained optimization with equality constraint, Necessary and sufficient condition for a general NLPP (with one constraint), with m (<n) constraints, constrained optimization with inequality constraints (Kuhn – Tucker conditions).	13

TEXT BOOKS/REFERENCE BOOKS:

1. Operations Research: Kanti Swarup, P.K. Gupta

2. Operations Research: Theory and Applications: J.K. Sharma

3. Operations Research: H.A. Taha **Complex Analysis**

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Course code	Course subject	L	T	P	Credits
MMA- 107	**COMPLEX ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:
To demonstrate knowledge and understanding of the following fundamental concepts in:
the analytic function.

LEARNING OUTCOMES:
1. Understand and explain analytic function, Cauchy's theorem and cauchy's integral formula.
2. How to solve poisson's integral formula.
3. How to solve problems in conformal mapping.

Unit	Contents	Lectures
I	Analytic function, Cauchy- Riemann equations, Harmonic functions and Harmonic conjugate, Construction of analytic functions.	8
II	Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form. Index of a point with respect to a closed curve, Cauchy's inequality.	9
III	Poisson's integral formula, Morera's theorem. Liouville's theorem.Contour integral, Power series, Taylor's series, higher order derivatives, Laurent's series.	9
IV	Singularities of analytic functions, Fundamental theorem of algebra, Zeroes of analytic function, Poles, Residues, Residue theorem and its applications to contour integrals. Maximum modulus principle, Schwarz lemma, Open mapping theorem.	13
V	Definition and examples of conformal mappings. Standard transformations, Mobius transformations, their properties and classification, invariant points, cross ratio, Methods to find Mobius transformation. Meromorphic functions, the argument principle, Rouche's theorem.	13

TEXTBOOKS/REFERENCE BOOKS:

1. Real and Complex Analysis : W. Rudin
2. Complex Analysis : J.B. Convey
3. Complex Analysis : B. Chaudhary
4. Complex variables : S. Narayan
5. Foundation of Complex Analysis : S. Ponnusomy

Course code	Course subject	L	T	P	Credits
MMA- 109	**ORDINARY DIFFERENTIAL EQUATION**	4	0	0	4

LEARNING OBJECTIVES:
To demonstrate knowledge and understanding of the following fundamental concepts in: the differential equation.

LEARNING OUTCOMES:
1. Understand and explain ordinary differential equation.
2. Understanding of linear system of equations.
3. To solve the problems related to orthonormal functions.

Unit	Contents	Lectures
I	Existence of solution of ODE of first order, initial value problem, Ascoli's Lemma, Gronwall's inequality, Uniqueness of Solutions. Method of successive approximations, Existence and Uniqueness Theorem.	10
II	System of differential equations, nth order differential equation, Existence and Uniqueness of solutions, dependence of solutions on initial conditions and parameters.	10
III	Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian, Abel Liouville formula, Reduction of order, Adjoint systems and self adjoint systems of second order, Floquet Theory.	12
IV	Linear 2^{nd} order equations, preliminaries, Sturm's separation theorem, Sturm's fundamental comparison theorem, Sturm Liouville boundary value problem,	10
V	Characteristic values & Characteristic functions, Orthogonality of Characteristic functions, Expansion of a function in a series of orthonormal functions.	10

TEXTBOOKS/REFERENCE BOOKS:
1. Theory of Ordinary Differential Equations: E. Coddington & N. Levinson
2. Differential Equations: S.L. Ross

3. Ordinary Differential Equations & Stability Theory: D.A. Sanchez

SEMESTER-II

Course code	Course subject	L	T	P	Credits
MMA- 102	**LINEAR ALGEBRA**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving linear algebra.

LEARNING OUTCOMES:
1. To solve the problems related to vector spaces.
2. Use of the linear transformation.
3. Use of the bilinear forms and solve related problems.
4. To solve the problems related to inner product spaces.

Unit	Contents	Lectures
I	Vector Spaces Subspaces Basis and dimension Linear Transformations Quotient spaces direct sum. The matrix of a linear transformation, Duality.	11
II	Canonical Forms Eigenvalues and eigenvectors. The minimal polynomial Diagonalizable and triangulable operators.	10
III	The Jordan Form, Rational Form. Inner Product Spaces Inner Products Orthogonality.	9
IV	The adjoint of a linear transformation Unitary operators Self adjoint and normal operators Polar and singular value decomposition.	11
V	Bilinear Forms Definition and examples. The matrix of a bilinear form Orthogonality, Classification of bilinear forms	11

TEXTBOOKS/REFERENCE BOOKS:
1. Linear Algebra: K. Hoffman and Ray Kunje
2. Algebra: M. Artin
3. Linear Algebra: A.G. Hamilton
4. Linear Algebra: Vivek Sahai, Vikas Bist

Course code	Course subject	L	T	P	Credits
MMA- 104	**FUNCTIONAL ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving linear algebra.

LEARNING OUTCOMES:
1. To solve the problems related to normed linear spaces.

2. Understanding of Hilbert spaces.
3. To solve the problems related to linear transformation.

Unit	Contents	Lectures
I	Normed linear spaces, Banach spaces, Subspaces, Quotient Spaces, Equivalent, Norms.	**10**
II	Bounded linear Transformation/operators, Hahn Banach Theorem, Open mapping, Theorem, Closed Graph Theorem Uniform Boundedness Principle.	**11**
III	Inner Product spaces, Hilbert Spaces, Orthogonality of vectors, orthogonal complements and projection Theorem,	**10**
IV	Riesz Representation Theorem, Orthogonal Sets.	**10**
V	Operators on Hilbert Spaces, Self-Adjoint, Normal and unitary operators orthogonal projection operators.	**11**

TEXTBOOKS/REFERENCE BOOKS:

1. Functional Analysis: P.K. Jain, O.P. Ahuza and Khalil Ahamad
2. Topology and Modren Analysis: G.F. Simmons
3. Introductory functional Analysis with Applications: E. Kreyszig
4. Functional Analysis: B.V. Limaye

Course code	Course subject	L	T	P	Credits
MMA- 106	**NUMERICAL ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving numerical problems.

LEARNING OUTCOMES:
1. To solve the problems related to non-linear equations.

2. Understanding of various method to solve numerical integration.
3. To solve the problems related to ordinary differential equations.

UNIT	Contents	Lectures
I	Solution of non-linear equations: Functional iteration, Bisection, Secant, Regula-Falsi, Newton-Raphson, Rate of convergence of these methods. Solution of linear system of equations: Gauss elimination, Gauss-Seidal and Factorization methods, Condition of convergence of these methods.	**15**
II	Interpolation: Finite difference operators, Newton interpolation, Gauss Forward and backward interpolation formulae, Stirling's formula, Bessel's formula, Laplace Everett's formula, Newton's divided difference formula, Lagrange's Formula.	**12**
III	Numerical Differentiation, Numerical Integration: Newton-Cotes formulae, Trapeziodal rule, Simpson's 1/3 and 3/8 rule, Romberg integration, Gaussian integration.	**13**
IV	Solution of Ordinary Differential Equations: Taylor's series, Picard method of Successive approximations, Euler's method, Modified Euler's method, Runge-Kutta Method 4th order, Predictor-Corrector methods, Milne-Simpson's method, Adam's–Bashforth method.	**12**

TEXTBOOKS/REFERENCE BOOKS:

1. Applied Numerical Analysis :C. F. Gerald and P. O. Wheatley
2. Numerical Analysis for Scientific and Engineering Computations :M. K. Jain, S. R. K. Iyengar, R. K. Jain
3. Introduction to Numerical Analysis: S. S. Shastry, Prentice Hall of India.

Course code	Course subject	L	T	P	Credits

MMA- 108	PARTIAL DIFFERENTIAL EQUATION	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving partial differential equation.

LEARNING OUTCOMES:
1. To solve the problems related to the canonical forms.

2. Understanding of various types of differential equations.

Unit	Contents	Lectures
I	Classification of Second Order Partial Differential Equations. Canonical Forms: Canonical Form for Hyperbolic Equation, Canonical Form for Parabolic Equation, Canonical form for elliptic equation. Adjoint Operators.	**10**
II	Elliptic Differential Equations: Occurrence of the Laplace and Poisson Equations: Derivation of Laplace Equation, Derivation of Poisson Equation. Boundary Value Problems (BVPs). Some Important Mathematical Tools. Properties of Harmonic Functions. Separation of Variables.	**11**
III	Parabolic Differential Equations: Occurrence of the Diffusion Equation. Boundary Conditions. Elementary Solutions of the Diffusion Equation. Dirac Delta Function. Separation of Variables Method.	**10**
IV	Hyperbolic Differential Equations: Occurrence of the Wave Equation. Derivation of One-dimensional Wave Equation. Solution of One-dimensional Wave Equation by Canonical Reduction.	**10**
V	Vibrating String –Variables Separable Solution. Forced Vibrations –Solution of Nonhomogeneous Equation. Boundary and Initial Value Problem for Two-dimensional Wave Equation –Method of Eigen function. Periodic Solution of One-dimensional Wave Equation.	**11**

TEXTBOOKS/REFERENCE BOOKS:

1. Introduction to Partial Differential Equations: K. Sankara Rao.
2. Partial Differential Equations: P.K. Mittal.

Course code	Course subject	L	T	P	Credits

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MMA- 110	CALCULUS OF VARIATIONS	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving calculus of variations.

LEARNING OUTCOMES:
1. To solve the problems related to the variation of function.

2. To solve the problems related to the isoperimetric problem.
3. Understand the idea of canonical forms of Euler equations.

Unit	Contents	Lectures
I	Variation of function: Necessary condition for an extremum. Euler's equation, fixed end point problem for unknown functions. Variational problems in parametric form.	**10**
II	Functional depending on higher order derivatives and variational problems with subsidiary condition.	**8**
III	The isoperimetric problem, Invariance of Euler's equation under coordinate transformation, General variational of functional, Variable end point problems. Transversality condition transversal theorem, Weierstrass Endmann corner condition.	**12**
IV	Cononical form of Euler equations and their first integrals. Cononical transformation, Noether's theorem, the principle of least action, Conservation law, Hamilton Jacobi's equations, Jacobi's theorem.	**11**
V	The second variation of a functional and the formula for second variation, Legendre's necessary condition. Jacobi's necessary condition, Conjugate point, sufficient condition for a weak extremum.	**11**

TEXTBOOKS/REFERENCE BOOKS:
1. Calculus of Variation: Gelfran and Fomin
2. Calculus of Variations: Esgolac
3. Calculus of Variations: Gupta
4. Calculus of Variations: S. Pundir

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SEMESTER-III

SCHOOL OF BASIC & APPLIED SCIENCES (DEPARTMENT OF MATHEMATICS)

Course code	Course subject	L	T	P	Credits
MMA- 201	**TOPOLOGY**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving metric spaces.

LEARNING OUTCOMES:
1. To solve the problems related to the metric space.

2. To solve the problems related to the topological spaces.
3. To solve the problems related to the homeomorphism.

Unit	Contents	Lectures
I	Metric space: open sets, closed sets, closure, interior, exterior, dense and non-dense sets, sequence and subsequence in metric space, complete metric spaces, Cantor's intersection theorem, Baire's category theorem.	**12**
II	Definition and example of topological spaces, closed sets closure dense subsets, neighborhood, interior and boundary.	**9**
III	Accumulation points and derived sets, base and sub bases, subspace and relative topology, Kuratowski closer operator and neighborhood system.	**10**
IV	Continuity and homeomorphism. Connectedness: connected and disconnected sets, local connectedness, component and path components, continuity and connectedness, totally disconnected space.	**11**
V	First and second countable spaces, separability and Lindel of property. T1 spaces, Hausdorff spaces, regular spaces, normal space, and completely normal spaces.	**10**

TEXTBOOKS/REFERENCE BOOKS:

1. Topology: A First Course: James R. Munkres
2. General Topology: J. L. Kelly
3. Topology and Modern Analysis: G.F. Simmons
4. General Topology: Seymour Lipschutz

Course code	Course subject	L	T	P	Credits
MMA- 203	**MEASURE AND INTEGRATION**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving measurable functions.

LEARNING OUTCOMES:
1. To solve the problems related to the denumerable sets.
2. To solve the problems related to the Lebesgue measure and Lebesgue integrals.
3. To solve the problems related to the measurable functions.

Unit	Contents	Lectures
I	Denumerable sets, Uncountable sets, Cardinal numbers.	**10**
II	Lebesgue measure, Measurable sets, Borel sets, Cantor's ternary sets and their properties.	**11**
III	Measurable functions, set of measure zero, the structure of measurable functions.	**11**
IV	Lebesgue Integrals and their properties, Lebesgue integrals for unbounded functions	**11**
V	General Lebesgue integrals.	**9**

TEXTBOOKS/REFERENCE BOOKS:

1. Real Analysis: H.L. Royden
2. An Introduction to Measure and Integration: Inder K. Rana
3. Lebesgue Measure and Integration: P.K. Jain and V.P. Gupta

4. Measure Theory and Integration: G. De. Barra

Course code	Course subject	L	T	P	Credits
MMA- 205	**PROBABILITY AND STATISTICS**	4	0	0	4

LEARNING OBJECTIVES:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving probability function.

LEARNING OUTCOMES:
1. To solve the problems related to the probability.

2. To solve the problems related to the Mathematical Expectation.
3. To solve the problems related to the hypothesis testing.

Unit	Contents	Lectures
I	Probability: Definition of probability-classical, relative frequency, statistical and axiomatic approach, Addition theorem, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes' theorem and its applications.	**7**
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. Mathematical Expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties.	**8**
III	Discrete distributions: Binomial, Poisson and geometric distributions with their properties. Continuous distributions: Uniform, Exponential, Gamma and Normal distributions with their properties.	**8**
IV	Testing of Hypothesis: Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors.	**8**
V	Tests of significance: Large sample tests for single mean, single proportion, difference between two means and two proportions; Definition of Chi-square statistic, Chi-square tests for goodness of fit and	

	independence of attributes. One way and two way ANOVA.	

TEXTBOOKS/REFERENCE BOOKS:

1. Mood, A.M., Graybill, F.A. and Boes, D.C., Mc Graw Hill Book Company.
2. Freund, J.E., Mathematical Statistics, Prentice Hall of India.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

Course code	Course subject	L	T	P	Credits
MMA- 207(1)	**CLASSICAL MECHANICS**	4	0	0	4

LEARNING OBJECTIVES:
Connect the advance quantum mechanics with previous knowledge and learn the basic properties of quantum world.

LEARNING OUTCOMES:
1. To solve the problems related to the D'Alemberts Priciple.

2. To solve the problems related to the Conservation Theorem.
3. To solve the problems related to the Kepler Problem.
4. To solve the problems related to the Kinematics of Rigid Body Motion.

Unit	Contents	Lectures
I	Basic Principles: Mechanics of a Particle and a System of Particles, Constraints, Generalized Coordinates, Holonomic and Non-Holonomic Constraints. D'Alemberts Priciple and Lagrange's Equations, Velocity Dependent Potentials and the Dissipation Function. Variational Principles and Lagrange's Equations: Hamilton's Principle, Derivation of Lagrange's Equations from Hamilton's Principle, Extension of Hamilton's Principle to Non-Holonomic Systems.	**11**
II	Conservation Theorems and Symmetry Properties: Cyclic Coordinates Canonical Momentum and its Conservation, The Generalized Force, and Angular Momentum Conservation Theorem. The Two-Body Central Force Problem: Reduction to the Equivalent One-Body Problem, The Equation of Motion, The Equivalent One Dimensional Problem and the Classification of Orbits.	**11**
III	The Kepler Problem: Inverse Square Law of Force, The Motion in Time in the Kepler Problem, Kepler's Laws, Kepler's Equation, The Laplace-Runge-Lenz Vector.	**9**
IV	Scattering in a Central Force Field: Cross Section of Scattering, Rutherford scattering Cross Section, Total Scattering Cross Section and Transformation of the Scattering Problem to Laboratory Coordinates.	**10**
V	The Kinematics of Rigid Body Motion: The Independent Coordinates of	**11**

	Rigid Body, The Transformation Matrix, The Euler Angles, The Cayley-Klein Parameters and Related Quantities, Euler's Theorem on the Motion of Rigid Bodies, Finite Rotations, Infinitesimal Rotations.	

TEXTBOOKS/REFERENCE BOOKS:

1. Lectures in Analytic Mechanics, F. Gantmacher
2. Classical Mechanics, P.V. Panat,
3. Classical Mechanics, N.C. Rana and P.S. Joag
4. Classical Mechanics K. Sankra Rao

Course code	Course subject	L	T	P	Credits
MMA- 207(II)	**ADVANCED DISCRETE MATHEMATICS**	4	0	0	4

LEARNING OBJECTIVES:

Connect the advance discrete mathematics with previous knowledge and learn the basic properties of discrete mathematics.

LEARNING OUTCOMES:

1. To solve the problems related to the Boolean Algebra.

2. To solve the problems related to the Permutations and Combinations.
3. To solve the problems related to the graph.
4. To solve the problems related to the tree.

Unit	Contents	Lectures
I	Boolean Algebras: Logic, Propositional Equivalences, Predicates and Quantifiers. Partial Ordered Sets, Lattices and Algebraic Systems, Principle of Duality, Basic Properties of Algebraic Systems defined by Lattices, Distributive and Complemented Lattices, Boolean Lattices and Boolean Algebras, Uniqueness of Finite Boolean Algebras, Boolean Functions and Boolean Expressions, Propositional Calculus. Pigeonhole principle.	**12**
II	Generating Permutations and Combinations Generating permutations, Inversions in permutations, Generating combinations, Partial orders and equivalence relations.	**9**
III	Recurrence Relations and Generating Functions Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, generating functions.	**9**
IV	Directed graphs, Digraph and Binary relations, Euler's digraph, Directed path & connectedness, acyclic digraph Eulerian trails, Hamilton chains and cycles, Bipartite multigraphs. Matrix Representation of Graphs.	**11**

	Chromatic number, Plane and planar graphs.	
V	Trees and fundamental circuit, Distance and centers, Binary Trees, Binary search, Spanning trees, Spanning trees, Algorithms, Primes and Kruskals, Dijkststra Algorithm, Fundamental circuits, Spanning trees in a weighted graphs and dual graphs.	**11**

TEXTBOOKS/REFERENCE BOOKS:

1. Basic Graph Theory: Parthswarthy
2. Graph Theory: N. Deo
3. Graph Theory and Application: C. Vashudev
4. Graph Theory: Harry

Course code	Course subject	L	T	P	Credits
MMA-207(III)	**MATHEMATICAL MODELING**	4	0	0	4

LEARNING OBJECTIVES:
Connect the advance mathematical modeling with previous knowledge and learn the technique of mathematical modeling.

LEARNING OUTCOMES:
1. Understand techniques of mathematical modeling.

2. To solve the problems related to linear and nonlinear models.
3. To solve the problems related to Mathematical modeling through partial differential equations.
4. To solve the problems related to Stochastic models.

Unit	Contents	Lectures
I.	Introduction and the technique of mathematical modeling, Classification and characteristics of mathematical models. Mathematical modeling through algebra, Finding the radius of the earth, Motion of planets, Motions of satellites. Linear and Non-linear growth and decay models, Population growth models. Effects of Immigration and Emigration on Population size, Decrease of temperature, Diffusion, Change of price of a commodity, Logistic law of population growth. A simple compartment model. Diffusion of glucose or a Medicine in the blood stream.	**13**
II	Mathematical modelling of epidemics, A simple epidemics model, A susceptible – infected - susceptible (SIS) model, SIS model with constant number of carriers, Simple epidemic model with carriers, Model with	**9**

	removal, Model with removal and immigration.	
III	Mathematical modelling in economics, Domar macro model, Domar first debt model, Domar second debt model, Samuelson investment model, Stability of market equilibrium. Mathematical modelling in medicine, Arms race and battles: A model for diabetes mellitus, Richardson model for arms race, Lamechester combat model.	**10**
IV	Mathematical modeling through partial differential equations: Mass-balance Equations, Momentum-balance Equations, variational principles, Probability generating function, Modeling for traffic on a highway.	**9**
V	Stochastic models of population growth Need for stochastic models, Linear birth-death immigration-emigration processes, Linear birth-death process, Linear birth-death immigration process, Linear birth-death-emigration process, Non-linear birth-death process.	**11**

TEXTBOOKS/REFERENCE BOOKS:

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 Mclone, Butterworths (Pub.) Inc.

Course code	Course subject	L	T	P	Credits
MMA-207(IV)	**THEORY OF FIELD EXTENSIONS**	4	0	0	4

LEARNING OBJECTIVES:
Connect the theory of field extensions with previous knowledge and learn the basic properties of theory of field extensions.

LEARNING OUTCOMES:
1. To solve the problems related to Extension of fields.

2. To solve the problems related to Galios theory.
3. To solve the problems related to Cyclic extension.
4. To solve the problems related to Extension by radicals.

Unit	Contents	Lectures
I	Extension of fields: Elementary properties, Simple Extensions, Algebraic and transcendental Extensions.	**9**
II	Factorization of polynomials, Splitting fields, Algebraically closed fields, Separable extensions, Perfect fields.	**9**
III	Galios theory: Automorphism of fields, Monomorphisms and their linear independence, Fixed fields, Normal extensions, Normal closure of an extension, The fundamental theorem of Galois theory, Norms and traces.	**12**
IV	Normal basis, Galios fields, Cyclotomic extensions, Cyclotomic polynomials, Cyclotomic extensions of rational number field, Cyclic extension, Wedderburn theorem.	**11**
V	Ruler and compasses construction, Solutions by radicals, Extension by radicals, Generic polynomial, Algebraically independent sets, Insolvability of the general polynomial of degree $n \geq 5$ by radicals.	**11**

TEXTBOOKS/REFERENCE BOOKS:
1. I.S. Luther and I.B.S.Passi, Algebra, Vol. IV-Field Theory, Narosa Publishing House, 2012.

2. Ian Stewart, Galios Theory, Chapman and Hall/CRC, 2004.
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. S. Lang, Algebra, 3rd editioin, Addison-Wesley, 1993.
6. Ian T. Adamson, Introduction to Field Theory, Cambridge University Press, 1982.
7. I.N.Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

Course code	Course subject	L	T	P	Credits
MMA- 209(I)	**SPECIAL FUNCTION**	4	0	0	4

LEARNING OBJECTIVES:
Connect the special function with previous knowledge and learn the basic properties of special function.

LEARNING OUTCOMES:
1. To solve the problems related to Legendre polynomials.

2. To solve the problems related to Bessel functions.
3. To solve the problems related to Hermite Functions.
4. To solve the problems related to Laguerre Functions.

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Unit	Contents	Lectures
I	Legendre Functions: Legendre polynomials, Recurrence relations for the Legendre polynomials, The formulae of Murphy and Roderigues, Series of Legendre polynomials, Legendre's differential equation, Neumann's formula for the Legendre functions, Recurrence relations for the functions Qn(μ), The use of Legendre functions in potential theory and wave mechanics.	**12**
II	Bessel Functions: The origin of Bessel functions, Recurrence relations for the Bessel coefficients, Series expansions for the Bessel coefficients, Integral expressions for the Bessel coefficients, The addition formula for the Bessel coefficients, Bessel's differential equation, Spherical Bessel functions.	**12**
III	Integrals involving Bessel functions, The modified Bessel functions, The Ber and Bei functions, Expansions in series of Bessel functions, The use of Bessel functions in potential theory.	**10**

IV	Hermite Functions: The Hermite polynomials, Hermite's differential equation, Hermite functions, and the occurrence of Hermite functions in wave mechanics.	**9**
V	Laguerre Functions: The Laguerre polynomials, Laguerre's differential equation, the associated Laguerre polynomials and functions, the wave functions for the hydrogen atom.	**9**

TEXTBOOKS/REFERENCE BOOKS:

1. I. N. Sneddon: Special Functions of Mathematical Physics and Chemistry, Edinburg, Oliver & Boyd, 1956.
2. G. Andrews, R. Askey & R. Roy, Special Functions, Cambridge, 1999.
3. L. Andrews, Special Functions for Engineers and Applied Scientists, Macmillan, 1985.
4. N. N. Lebedev, Special Functions & Their Applications, Revised Edition, Dover, 1976.
5. Mathematical Method: J.N. Sharma
6. Mathematical Method: P.K.Mittal, Shanti Narayan

Course code	Course subject	L	T	P	Credits
MMA- 209(II)	**SPECIAL FUNCTION**	4	0	0	4

LEARNING OBJECTIVES:
Connect the fuzzy sets with previous knowledge and learn the basic properties of fuzzy sets.

LEARNING OUTCOMES:
1. To solve the problems related to fuzzy sets.

2. To solve the problems related to fuzzy Arithmetic.
3. To solve the problems related to Possibility Theory.
4. Understand the applications of fuzzy Logic.

.

Unit	Contents	Lectures
I	Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, a-cuts, Properties of a-cuts, Decomposition Theorems, Extension Principle. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of operations, Aggregation Operations.	**11**
II	Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on intervals and Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.	**9**
III	Possibility Theory: Fuzzy Measures, Evidence and Possibility Theory, Possibility versus Probability Theory.	**9**
IV	Fuzzy Relations: Crisp and Fuzzy Relations, Projections and Cylindric Extensions, Binary Fuzzy Relations, Binary Relations on single set, Equivalence, Compatibility and Ordering Relations, Morphisms, Fuzzy Relation Equations. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.	**12**
V	Uncertainty based Information: Information and Uncertainty, Non-specificity of Fuzzy and Crisp sets, Fuzziness of Fuzzy Sets. Applications	**11**

	of Fuzzy Logic.	

TEXTBOOKS/REFERENCE BOOKS:

1. Fuzzy Sets: Uncertainty and Information: Klir G. J. and Folyger T. A.
2. Fuzzy sets and Fuzzy logic: Theory and Applications: Klir G. J. and Yuan B.
3. Fuzzy Set Theory and its Applications: Zimmermann H.J.

Course code	Course subject	L	T	P	Credits
MMA-209(III)	**MECHANICS OF SOLIDS**	4	0	0	4

LEARNING OBJECTIVES:
Connect the advance quantum mechanics with previous knowledge and learn the basic properties of quantum world.

LEARNING OUTCOMES:
1. To solve the problems related to tensors.

2. To solve the problems related to stress vector.
3. To solve the problems related to strain.
4. Understand the applications of elasticity.

Unit	Contents	Lectures
I	Cartesian tensors of different orders, Contraction of a tensor, Multiplication and quotient laws for tensors, Substitution and alternate tensors, Symmetric and skew symmetric tensors, Isotropic tensors, Eigenvalues and eigenvectors of a second order symmetric tensor.	**11**
II	Analysis of Stress: Stress vector, Normal stress, Shear stress, Stress components, Cauchy equations of equilibrium, Stress tensor of order two, Symmetry of stress tensor, Stress quadric of Cauchy, Principal stresses, Stress invariants, Maximum normal and shear stresses, Mohr diagram.	**11**
III	Analysis of Strain: Affine transformations, Infinitesimal affine deformation, Pure deformation, Components of strain tensor and their geometrical meanings, Strain quadric of Cauchy, principal strains, Strain invariants, General infinitesimal deformation, Saint-Venant conditions of compatibility, Finite deformations.	**11**
IV	Equation of Elasticity: Generalized Hook's law, Hook's law in an elastic media with one plane of symmetry, Orthotropic and transversely isotropic symmetries,	**9**
V	Homogeneous isotropic elastic media, Elastic moduli for an isotropic media, Equilibrium and dynamical equations for an isotropic elastic media, Beltrami - Michell compatibility conditions.	**10**

TEXTBOOKS/REFERENCE BOOKS:

1. I.S. Sokolnikoff, Mathematical theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Teodar M. Atanackovic and Ardeshiv Guran, Theory of Elasticity for Scientists and Engineers, Birkhausev, Boston, 2000.
3. Saada, A.S., Elasticity-Theory and applications, Pergamon Press, New York.
4. D.S. Chandersekhariah and L. Debnath, Continuum Mechanics, Academic Press, 1994.
5. Jeffreys, H., Cartesian tensors.
6. A.K. Mal & S.J. Singh, Deformation of Elastic Solids, Prentice Hall, New Jersey, 1999

Course code	Course subject	L	T	P	Credits
MMA-209(IV)	**MULTIVARIATE ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:

Connect the multivariate analysis with previous knowledge and learn the properties of multivariate analysis.

LEARNING OUTCOMES:

1. To solve the problems related to normal distribution.
2. To solve the problems related to multiple correlations.
3. To solve the problems related to wishart matrix.
4. Understand the applications of Cluster analysis.

.

Unit	Contents	Lectures
I	Multivariate normal distribution, Marginal and conditional distributions, Characteristic function. Distribution of linear combinations of normal vector.	**10**
II	Maximum likelihood estimators of mean vector and covariance matrix. Distributions of sample mean vector, Distribution of quadratic forms.	**10**
III	Correlation coefficient of a bivariate sample, Partial and multiple correlation n coefficients.	**9**
IV	Derivation of generalised T2 -statistic and its distribution, Uses of T2 -statistic. The problem of classification, Procedures of classification of one of the two populations with known probabilities. Wishart matrix - its distribution (without proof) and properties. Generalised variance.	**12**
V	Principal components, Maximum likelihood estimators of principal components and their variances. Canonical correlations and variates, Estimation of canonical correlations and variates. Cluster analysis.	**11**

TEXTBOOKS/REFERENCE BOOKS:

1. T.W. Anderson, An Introduction to Multivariate Statistical Analysis, John Wiley.
2. C.R. Rao, Linear Statistical Inference and its Applications, John Wiley.
3. R.A. Johnson and D.W. Wichern, (2001), Applied Multivariate Statistical Analysis, Prentice Hall of India.
4. A.C. Rencher, (2002), Methods of Multivariate Analysis, 2nd Ed., John Wiley & Sons.

Course code	Course subject	L	T	P	Credits
MMA- 251	**MATLAB**	0	0	2	1

LEARNING OBJECTIVES:
The objective of the course Matlab is to expose the students of M.Sc. class to theoretical study by using matlab.

LEARNING OUTCOMES:
1. Understand the structure and features of matlab.
2. Understand the array and function file.

Unit	Contents	Lectures
I	**BASIC STRUCTURE and FEATURES OF MATLAB:** Command window; figure window; editor window and help window; arithmetic operations with scalars, order of precedence; using MATLAB as a calculator; display formats; elementary math built-in functions; scalar variables, assignment operator; predefined variables; useful commands for managing variables; applications in problem solving.	**11**
II	**CREATING ARRAYS** – one dimensional, two dimensional; array addressing; built-in functions for handling arrays; mathematical operations with matrices; strings and strings as variables; generation of random numbers; examples of MATLAB applications.	**11**
III	**SCRIPT FILES:** Creating and saving a script file, current directory; output commands.	**8**
IV	**TWO – DIMENSIONAL PLOTS:** Plot command; line specifiers plot of a given data; plot of a function; plotting multiple graphs in the same plot. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.	**12**
V	**FUNCTIONS AND FUNCTION FILES:** Creating a function file; input and output arguments; function body; comment lines; saving a function files; using a function file; programming in MATLAB.	**10**

TEXTBOOKS/REFERENCE BOOKS:

1. Gilat Amos, “MATLAB: An Introduction with Applications”, John Wiley & Sons, Inc (Wiley Student Edition), 2008.

2. Herniter, E. Marc, “Programming in MATLAB”, Brooks/Cole, Thomson Learning

Course code	Course subject	L	T	P	Credits
MMA- 253	**SYNOPSIS SEMINAR**	0	0	1	1

Description

Students are required to submit a synopsis on the allotted topic and must make a presentation in front of advisory committee and M.Sc. Students. Students are expected to provide latest facts and updated information by consulting latest editions of textbooks, reference books, monographs, and peer-reviewed national & international research journals.

S.No.	Course details
1.	Synopsis writing
2.	Synopsis seminar
3.	Approval of synopsis by research committee
4.	Research work by taking 13 credit hours

TEXTBOOKS/REFERENCE BOOKS:

1. Gilat Amos, “MATLAB: An Introduction with Applications”, John Wiley & Sons, Inc (Wiley Student Edition), 2008

2. Herniter, E. Marc, “Programming in MATLAB”, Brooks/Cole, Thomson Learning

Course code	Course subject	L	T	P	Credits
MMA- 255	**Dissertation**	0	0	4	2

Description
Students are required to work on the allotted topic and must make a presentation in front of advisory committee and M.Sc. Students. Students are expected to provide latest facts and updated information by consulting latest editions of textbooks, reference books, monographs, and peer-reviewed national & international research journals.

S.No.	**Course details**
1.	Research work
2.	Seminar
3.	Evaluation by Research committee
4.	Research work by taking 52 credit hours

SEMESTER-IV

Course code	Course subject	L	T	P	Credits
MMA- 202	**DIFFERENTIAL GEOMETRY**	4	0	0	4

LEARNING OBJECTIVES:

Connect the differential geometry with previous knowledge and learn the basic properties of geometry.

LEARNING OUTCOMES:

1. To solve the problems related to curves in space.

2. To solve the problems related to envelope.
3. To solve the problems related to Weingarten's equation.
4. Understand the applications of Monge's theorem.

.

Unit	Contents	Lectures
I	Curves in space; Arc length, Order of contact, Tangent, Normal, Binormal, Osculating, Plane, Serrent- Frenet formulae, Curvature and torsion. Osculating circle and osculating sphere, Helix, Bertand curves.	**11**
II	Behaviour of a curve in the neighbourhood of a point. Concept of a surface, Envelope and developable surface, Parametric curves, Family of the surfaces, Edge of regression, Ruled surfaces, Central points.	**11**
III	Fundamental forms and curvature of surfaces: First fundamental form. Second fundamental form of the surfaces of revolution, Weingarten's equation, Direction coefficients, Family of curves.	**11**
IV	Local non-intrinsic properties of a surface Normal curvature, Principal directions, Principal curvatures, Minimal surface	**9**
V	Lines of curvature. Rodrigues and Monge's theorem, Euler's theorem, Joachimisthal's theorem, Dupin's indicatrix, Third fundamental form.	**10**

TEXTBOOKS/REFERENCE BOOKS:

1. Differential Geometry : T.J. Willmore
2. Differential Geometry of Three Dimensions : C.E. Weathrburn
3. Elements of Differential Geometry : R.S. Millman & G.D. Par
4. Introduction to Differential Geometry : A. Goctz

Course code	Course subject	L	T	P	Credits
MMA- 204	**INTEGRAL EQUATIONS & BOUNDARY VALUE PROBLEMS**	4	0	0	4

LEARNING OBJECTIVES:

Connect the integral equation with previous knowledge and learn the concept of boundary value problems.

LEARNING OUTCOMES:

1. To solve the problems related to Green's function.
2. To solve the problems related to Fredholm Integral Equations.
3. To solve the problems related to Fredholm.
4. Understand the techniques of Perturbation.

.

Unit	Contents	Lectures
I	Classification of integral equations, Relation between Differential and Integral equations, Green's function.	**9**
II	Solution of Fredholm Integral Equations, Solution of Volterra Integral Equations.	**10**
III	Hilbert-Schmidt Theory and classical theory of Fredholm. Singular Integral equation and Numerical solution of Integral equations.	**11**
IV	Perturbation techniques and its applications to mixed boundary value problems, Two-part and three-part boundary value problems.	**11**
V	Solutions of electrostatic problems involving a charged circular disk and annular circular disk, a spherical cap, an annular spherical cap in a free space or a bounded space.	**11**

TEXTBOOKS/REFERENCE BOOKS:

1. Integral Equations : Hilderbrand

2. Linear Integral Equations : V. Lovit

3. Linear Integral Equations : R.P. Kanwal

4. Integral Equations : Li. G. Chanbers

Course code	Course subject	L	T	P	Credits
MMA- 206	**RESEARCH METHODOLY**	4	0	0	4

LEARNING OBJECTIVES:

This course would focus on research methodology and making a good interpretation of research. It would also provide brief information about various instruments used for characterization purpose.

LEARNING OUTCOMES:

1. Understand the basic ideas about research methodology.
2. Able to Understand research design.
3. Be able to learn about research techniques.
4. Understand the concept of research.

Unit	Contents	Lectures
I	**Research: a way of thinking:** Introduction to research, Research Process, defining research problem, Identification of a good research problem, Criteria for good research,	**10**
II	Significance of research, Techniques for defining research problem, how to prepare yourself for research, Introduction to Research Methodology, Research design, Problems encountered by the researchers.	**11**
III	**Data collection, interpretation, and research report:** Data collection, Interpretation of data, Field Research, Data analysis, Various Methods of Observation, Research Quoting, Interpretation is the climax of research process, Research paper Writing, Research work Presentations.	**12**
IV	**Research ethics and plagiarism:** values, standards and practices, scientific misconduct, human participation and animal subjects, authorship allocation of credit, competing interests, commitments and values. Definition, types of plagiarism, unintentional plagiarism.	**10**
V	Invention, Innovation, IPR : understanding of Invention & Innovation and its role in economic development, patents & copyrights, importance and basic knowledge of IPR.	**9**

TEXTBOOKS/REFERENCE BOOKS:

1. Research Methodology Methods and Techniques, C.R. Kothari, New Age Publication,(2004).
2. Research Methodology-Deepak Chawla and Neena sodhi, Vikas publication, (2011).

Course code	Course subject	L	T	P	Credits
MMA- 252	**Dissertation**	0	0	15	15

Description
Dissertation will carry marks for continuous assessment, dissertation write-up, its presentation and viva-voce. This will be evaluated at the end of fourth semester. Students will work on a research topic assigned to him/her by their supervisor/mentor with a purpose to develop a collective approach to study, analyze and solve the problem. Students are required to collect, analyze the data, and submit their dissertation at the end of the semester.

S.No.	**Course details**
1.	Research work
2.	Seminar
3.	Evaluation by Research committee
4.	Thesis writing
5.	Research work by taking 195 credit hours