Syllabus

B.Sc. (Hons) Mathematics

THREE-YEARS FULL-TIME PROGRAMME

(Six-Semester Course)

2024-27

CHOICE BASED CREDIT SYSTEM

LINGAYA'S VIDYAPEETH

choose to know

(u/s 3 of UGC Act 1956)

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 TERM	25
Assignment/Quiz/Tutorial/Viva-voce (**ABQ)**	15
End-Semester Examination	60

Practical Components/Practical Courses

Examination	**Sub-component**	**Weightage**	**Total**
Internal examination	Viva-voce + Continuous lab performance	**20+25+15**	**60**
End-Semester Practical Exam (External examination)	Viva-voce + Written exam + Practical record file	**20+20**	**40**

LINGAYA'S VIDYAPEETH

SCHEME OF STUDIES

SESSION: 2024-27

School : School of Basic and Applied Sciences	**Batch: 2024-2027**
Department: Mathematics	**Year: First**
Course: B.Sc. (Hons) Mathematics	**Semester: 1**

S N	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Sub Total Marks
								Theory		Practical			
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	**BS-101**	Wave and Optics	4	0	0	4	15	25	60	-	-	100
2	PCC	**BS-103**	Differential Calculus	4	0	0	4	15	25	60	-	-	100
3	GE	**BS-105**	Physical Chemistry-I	4	0	0	4	15	25	60	-	-	100
4	GE	**BS-151**	Wave and Optics Laboratory-I	0	0	4	2	-	-	-	60	40	100
5	GE	**BS-155**	Physical Chemistry Laboratory-I	0	0	4	2	-	-	-	60	40	100
6	AECC	**HSS-107**	English and Communication Skills	2	0	0	2	15	25	60	-	-	100
			Total---->	**14**	**0**	**8**	**18**	**60**	**100**	**240**	**120**	**80**	**600**

Abbreviations:

PCC:	Core Courses	ABQ:	Assignment Based Quiz
GE:	General Elective	MSE:	Mid Semester Examination
PRO:	Project	ESE:	End Semester Examination
L:	Lecture	EXP:	External Practical

School : School of Basic and Applied Sciences	Batch: 2024-2027
Department: Mathematics	Year: First
Course: B.Sc. (Hons) Mathematics	Semester: II

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	**BMH-102**	Integral Calculus	4	0	0	4	15	25	60	-	-	100
2	PCC	**BMH-104**	Discrete Mathematics	4	0	0	4	15	25	60	-	-	100
3	PCC	**BMH-106**	Algebra	4	0	0	4	15	25	60	-	-	100
4	DE	**BMH-108**	Logical Mathematics/Analytical Method in chemistry/Statistical Physics	4	0	0	4	15	25	60	-	-	100
5	SEC	**BMH-154**	Fundamental of computer	4	0	0	4	15	25	60	-	-	100
6	AECC	**CE-110**	Environmental Science & Ecology	2	0	0	2	15	25	60	-	-	100
			Total---->	**21**	**0**	**0**	**22**	**60**	**100**	**240**			**600**

School: School of Basic and Applied Sciences	Batch: 2024-2027

Department: Mathematics								Year: Second					
Course: B.Sc. (Hons) Mathematics								Semester: III					
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	**BMH-201**	Ordinary Differential Equation	4	0	0	4	15	25	60	-	-	100
2	SEC	**BMH-203**	Graph Theory	4	0	0	4	15	25	60	-	-	100
3	PCC	**BMH-205**	Real Analysis	4	0	0	4	15	25	60	-	-	100
4	DSC	**BMH-207**	Number Theory	4	0	0	4	15	25	60	-	-	100
5	PCC	**BMH-209**	Group Theory	4	0	0	4	15	25	60	-	-	100
6	DSC	**BMH-211**	Introduction of MATLAB	0	0	4	2	-	-	-	60	40	100
			Total--→	**24**	**0**	**4**	**22**	**75**	**125**	**300**	**60**	**40**	**600**

School : School of Basic and Applied Sciences								Batch: 2024-2027					
Department: Mathematics								Year: Second					
Course: B.Sc. (Hons) 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	**BMH-202**	Operation Research-I	4	0	0	4	15	25	60	-	-	100
2	PCC	**BMH-204**	Theory of Real Functions	4	0	0	4	15	25	60	-	-	100
3	PCC	**BMH-206**	PDE and its applications	4	0	0	4	15	25	60	-	-	100
4	PCC	**BMH-208**	Numerical Methods	4	0	0	4	15	25	60	-	-	100
5	SEC	**BMH-258**	Numerical Methods Lab	0	0	4	2	-	-	-	60	40	100
6	PCC	**BMH-210**	Multivariate Calculus	4	0	0	4	15	25	60			100
7	SEC	**BMH-254**	Operation Research-I Matlab	0	0	4	2	0	0	0	60	40	100
			Total--→	**20**	**0**	**8**	**24**	**75**	**125**	**300**	**120**	**80**	**700**

School : School of Basic and Applied Sciences								Batch: 2024-2027					
Department: Mathematics								Year: Third					
Course: B.Sc. (Hons) Mathematics								Semester: 5th					
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	**BMH-301**	Ring Theory &Linear Algebra –I	4	0	0	4	15	25	60	-	-	100
2	PCC	**BMH-303**	Analytical Geometry	4	0	0	4	15	25	60	-	-	100
3	DSC	**BMH-307**	Probability and Statistics	4	0	0	4	15	25	60	-	-	100
4	PCC	**BMH-309**	Riemann Integration and series of functions	4	0	0	4	15	25	60	-	-	100
5	PCC	**BMH-311**	Metric space	4	0	0	4	15	25	60	-	-	100
			Total---->	**20**	**0**	**0**	**20**	**75**	**125**	**300**			**500**

School : School of Basic and Applied Sciences								Batch: 2024-2027					
Department: Mathematics								Year: Third					
Course: B.Sc. (Hons) Mathematics								Semester:6th					
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	**BMH-302**	Operation Research-II	4	0	0	4	15	25	60	-	-	100
2	PCC	**BMH-304**	Complex analysis	4	0	0	4	15	25	60	-	-	100
3	PCC	**BMH-306**	Ring Theory & Linear Algebra-II	4	0	0	4	15	25	60	-	-	100
4	SEC	**BMH-350**	Operation Research-II MATLAB	0	0	4	2	-	-	-	40	60	100
5	PROJ	**BMH-352**	Minor project/seminar/Industrial Training	0	0	12	6	-	-	-		100	100
			Total---->	**12**	**0**	**16**	**20**	**45**	**75**	**180**	**40**	**160**	**500**

PROGRAM OUTCOMES:

PO1: Apply the technique of mathematics and its approach in the solution of different Mathematical Problem.
PO2: Identify, formulate, and analyse complex problems reaching substantiated conclusions using mathematical model and its solution approach.
PO3: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of numerical data to provide valid conclusions.
PO4: Students develop critical thinking skills to identify, analyze and solve problems of their core areas using modern tools.
PO5: Students develop lifelong learning skills with interdisciplinary approach towards sustainable development.
PO6: Ability to communicate effectively the comprehended scientific data and knowledge, write effective reports, design documentation and make effective presentations.
PO7: Apply ethical, moral and social values in personal and professional life leading to highly cultured and civilized society.
PO8: Ability to work effectively as an individual or as a member or Team leader in diverse teams and in multidisciplinary environment.

PROGRAM SPECIFIC OUTCOMES:

PSO01: Students acquire knowledge of traditional and modern techniques of solving algebraic, transcendental equations, system of linear differential and integral equations, which have applications in many disciplines.
PSO02: The students attain sound knowledge in the areas of Mechanics, Thermal Physics, Waves and oscillations, optics, electromagnetism, modern physics, solid-state physics for pursing higher education and research.

B.Sc. Hons (MATHEMATICS)

(1st SEMESTER)

Course code	Course subject	L	T	P	Credits
BS 101	**Wave and Optics**	**4**	**0**	**0**	**4**

LEARNING OBJECTIVES: Learn the mathematical methods to solve the problems involving electric potential and fields.
LEARNING OUTCOMES: 1. Master the mathematical tools to find electric potential and fields. 2. Learning of important theorems as Gauss theorem. 3. Calculating the electric fields around conductors.

Unit	Contents	Lectures

I	Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats).Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.	8
II	Wave Motion & Velocity of Waves: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton‘s Formula for Velocity of Sound waves and Laplace‘s correlation	14
III	superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde‘s Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N	10
IV	Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Interference: Division of amplitude and wavefront. Young‘s double slit experiment. Lloyd‘s Mirror and Fresnel‘s Biprism. Phase change on reflection:Stokes‘ treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton‘s Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer	10
V	Diffraction: Kirchhoff ‘s Integral Theorem, Fresnel-Kirchhoff ‘s Integral formula and its application to rectangular slit. Fraunhofer Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel ‘s Assumptions. Fresnel ‘s Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel ‘s Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	10

TEXT BOOKS/REFERENCE BOOKS:

Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

1. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill

2 Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

3 Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

4 The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

5 The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Course code	Course subject	L	T	P	Credits
BS 105	**BS-105: Physical Chemistry-I**	4	0	0	4

LEARNING OBJECTIVES:

1. To understand the shapes of different orbitals.
2. To understand different principles for filling electrons.
3. To understand how to draw energy diagrams.
4. To understand how to calculate bond order.
5. To understand how to calculate lattice energy through Born Haber Cycle

LEARNING OUTCOMES:

1. Student will evaluate the periodic properties of elements.
2. To learn and explain electronic structure of atom.
3. To learn, understand and relate the quantum numbers and atomic orbitals.
4. Illustrate the explanation of atomic structure.

Unit	Contents	Lecture/Tutor
I	Chemical Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and vander Waals) under isothermal and adiabatic conditions.	9
II	Themo chemistry: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity.	12
III	Systems of Variable Composition: Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.	11

IV	Chemical Equilibrium: Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelie principle (quantitative treatment.)	13
V	Solutions and Colligative Properties: Dilute solutions; lowering of vapour pressure, Raoult‘s and Henry‘s Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point,(iii) Depression of freezing point, (iv) osmotic pressure and amount.	7

TEXTBOOKS/REFERENCE BOOKS:

.Peter, A. & Paula, J. de. Physical Chemistry 10th Ed., Oxford University Press (2014).
2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4.McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.:
5.Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6.Levine, I .N. Physical Chemistry 6th Ed., Tata McGraw Hill (2010).
7.Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

Course code	Course subject	L	T	P	Credits
BS 151	**Wave and Optics Laboratory-I**	0	0	4	2

LEARNING OBJECTIVES:

The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

S. No.	Practical Description
1.	. To determine the frequency of an electric tuning fork by Melde‘s experiment and verify λ 2 –T law
2.	To investigate the motion of coupled oscillators.
3.	To study Lissajous Figures.
4.	Familiarization with: Schuster`s focusing; determination of angle of prism.
5.	To determine refractive index of the Material of a prism using sodium source.
6.	To determine the dispersive power and Cauchy constants of the material of a prism using mercury Source
7.	To determine the wavelength of sodium source using Michelson‘s interferometer.
8.	To determine wavelength of sodium light using Fresnel Biprism
9.	To determine wavelength of sodium light using Newton‘s Rings.
10.	To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film
11.	To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12.	To determine dispersive power and resolving power of a plane diffraction grating.
13.	To determine self-inductance of a coil by Rayleigh’s method.

TEXTBOOK/REFERENCE BOOKS:

Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

1. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

2 Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

3 A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

Course code	Course subject	L	T	P	Credits
BS 155	**PHYSICAL CHEMISTRY LABORATORY-I**	0	0	4	2

LEARNING OBJECTIVES:

The objective of the course Laboratory is to expose the students of M.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

LEARNING OUTCOMES:

1.Structure identification through IR, NMR and Mass spectroscopic data

2. Lab/Instrumentation techniques used for analyzing reaction mechanisms.

S. No.	Practical Description
1	**Titrimetric Analysis:** Calibration and use of apparatus Preparation of solutions of different Molarity/Normality of titrants
2	Estimation of carbonate and hydroxide present together in mixture.
3	Determination of viscosity of (i) ethanol (ii) amyl alcohol and (iii) aqueous solution of sugar at room temperature
4	Estimation of free alkali present in different soaps/detergents
5	Determine the surface tension of given solution using drop number method.
6	**Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boiling point**: (i) Phenyl benzoate from phenol and benzoyl chloride (ii) M-dinitrobenzene from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available). (iii) Picric acid (iv) Aspirin from salicylic acid
7	Crystallization and decolourization of impure naphthalene from ethanol.

Reference Books:

1. O.P. Pandey, D.N. Bajpai& S. Giri, Practical Chemistry, S. Chand & CompanyLtd.
2. B. D. Khosla, V. C. Garg& A. Gulati, *Senior Practical Physical Chemistry,* S. Chand & Co.: New Delhi(2011).

Course code	Course subject	L	T	P	Credits
BS- 103	**DIFFERENTIAL CALCULUS**	4	0	0	4

LEARNING OBJECTIVES:

1. Understand the major concepts of differentiation with application in Applied Mathematics.
2. Appreciate how calculus allows us to solve important practical problems in an optimal way.

LEARNING OUTCOMES:

1. Interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function.
2. Calculate the limit of a function at a point numerically and algebraically using appropriate techniques including L'Hospital's rule.

Unit	Contents	Lectures
I	Methods of differentiations of various functions, Limit and Continuity of real valued functions, Left hand limit, Right hand limit, and Algebra of limits of real valued functions. Evaluations of limits using Factorization	9

	and limits at infinity of algebraic and trigonometric functions. Continuity and theorems for continuous functions and evaluations by use of theorems. Differentiability and derivative of real valued functions using continuity principles.	
II	Successive differentiations and evaluations of n^{th} order derivatives using Leibnitz theorem. Mean-value theorem and its applications, Roll's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Expansions of functions of one variable, Maclaurin and Taylor's theorem. Expansions function of several variables using Taylor series, Approximations of functions.	9
III	Geometrical applications of differential calculus: Curvature, center of curvature, Centre and Circle of curvature and equations of circle of curvature. Introduction of Envelope and Evolutes, Equations of Tangent and Normal, representation of functions of two variables, Asymptotes and curve tracing of Cartesian, polar form, parametric functions.	9
IV	Partial Differentiation and its applications, Limits and continuity of functions of two variables; Homogeneous function Euler's theorem Taylor's theorem and Higher order partial derivatives, Maxima and minima for functions of several variables, Lagrange's multiplier	9

TEXTBOOKS/REFERENCE BOOKS:

1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
3. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) Ltd. (Pearson Education), Delhi, 2007.
4. A Text book of Differential Calculus NEP (2000) pattern: S R Singh& Dharmendra Yadav, Kedar Nath, Ram Nath Publication Meerut.
5. Advance Engineering Mathematics: Erwin Kreyszig, John Willy & Sons 2011.

B.Sc. Hons (MATHEMATICS)

(2^{nd} SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH- 102	**Integral Calculus**	4	0	0	4

LEARNING OBJECTIVES:

1. Students should be helped to make connections and build relationships between integral calculus and its applications in real word problems like Engineering and solid Geometry.
2. The course will enhance research, inquiry and analytical thinking abilities of students.

LEARNING OUTCOMES:

1. Students will learn to transform between bases, including the creation, realistic connections, and the application in Engineering and real word problems.
2. Students will learn Fundamental Theorem of calculus, evaluations of .area, volume, mass, center of Gravity, Moment of Inertia.

Unit	Contents	Lectures
I	Integration by first principle, evaluation of integrals of basic function (Algebraic functions, Exponential functions, Trigonometric functions and Logarithmic functions). Integration by decompositions in partial functions, Rational algebraic functions making perfect square and changing in standard forms. Integration of trigonometric function by using reduction formulas. Evacuations of integrals of $\int sin^m(x)dx, \int cos^m(x)dx, \int sin^m(x)cos^n(x)dx, \int cos^m(x)sin^n(x)dx, \int e^{ax}sin^n(bx)d$ $\int e^{ax}cos^n(bx)dx,$	10
II	Introduction of Double integration and its application, change of order in double, change of variable, Evaluation of areas, volume, Center of Gravity, Moment of Inertia using double integration. Improper integrals, Beta and Gamma function and applications.	8
III	Introduction of triple integration and its application, Evolutions of volume of solids like Sphere, Ellipsoid and other shapes in using triple integration. Dirichlet theorem, Liouville theorem applications in evaluations of integrals. Evaluation of integrals, Gauss divergence theorem and its application	8
IV	Vector Differentiation and Integration, of vectors, gradient of a scalar field, directional derivative, divergence of a vector field, curl and scalar potential function and evaluation, line integrals, surface integrals and volume integrals with applications, Stokes' theorem, Green's theorem and Gauss divergence theorem and applications	8

TEXTBOOKS/REFERENCE BOOKS:

1. Integral calculus: Shanti Narayan& P. K. Mittal, S. Chand publisher, 2005.

2. Calculus Vol. II: T. M Apostol, John Willy Publication, 1974.

3. Advance Engineering Mathematics: Erwin Kreyszig, John Willy & Sons 2011.

Course code	Course subject	L	T	P	Credits
BMH-108	Logical Mathematics	4	0	0	4

LEARNING OBJECTIVES:

1.The course emphasizes rigorous reasoning

2 development of abstract thinking skills essential for advanced study in mathematics and computer science.

LEARNING OUTCOMES:

1. understand and apply the principles of propositional and predicate logic.

2Develop skills in formal proof techniques, including direct, indirect, and proof by contradiction.

3 Analyse and construct mathematical arguments involving sets, relations, and functions.

4Understand the concepts of mathematical induction and recursion.

Unit	Contents	Lectures
I	**Unit 1:** Unit 1: Propositional Logic: **Basic Concepts:** Propositions and logical connectives, Truth table, Logical equivalence **Propositional Calculus:** Tautologies and contradictions, Logical implications, Normal forms (CNF, DNF)	10
II	**Unit 2:** Unit 2: Predicate Logic: **Predicates and Quantifiers:** Universal and existential quantifiers, Bound and free variables, **Predicate Calculus:** Logical equivalences involving quantifiers, Translating statements to and from predicate logic	8
III	Unit 3: Proof Techniques: **Methods of Proof:** Direct proof, Proof by contraposition, Proof by contradiction, **Mathematical Induction:** Principle of mathematical induction, Strong induction, Induction in proofs involving inequalities.	14
IV	Unit 4: Set Theory: **Basic Concepts:** Sets and subsets, Venn diagrams, Operations on sets (union, intersection, difference, complement), **Advanced Set Theory:** Cartesian products, Power sets, Principles of inclusion-exclusion.	12

V	Relations, Functions, and Combinatorics: **Relations:** Properties of relations (reflexive, symmetric, transitive), Equivalence relations, Partial orderings, **Functions:** Definitions and types of functions, Injections, surjections, and bijections, Inverse functions and compositions, **Combinatorics,** Basic counting principles, Permutations and combinations, Pigeonhole principle, Binomial theorem.	15

TEXTBOOKS/REFERENCE BOOKS:

- Discrete Mathematics and Its Applications" by Kenneth H. Rosen
- "Mathematical Logic" by Ebbinghaus, Flum, and Thomas
- "How to Prove It: A Structured Approach" by Daniel J. Velleman
- "Introduction to the Theory of Computation" by Michael Sipser (for additional reading on logic and computation)

Course code	Course subject	L	T	P	Credits
BMH-106	**ALGEBRA**	4	0	0	4

LEARNING OBJECTIVES:

1. Students should be helped to make connections and build relationships between algebra and arithmetic, geometry, and probability and statistics.
2. The course will enhance research, inquiry and analytical thinking abilities of students.

LEARNING OUTCOMES:

3. Students will learn to transform between bases, including the creation, geometric connections, and the application of orthogonal and orthonormal bases.
4. Students will learn Fundamental Theorem of Arithmetic.

Unit	Contents	Lectures
I	Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.	8
II	Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.	8

III	Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.	8
IV	Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.	8
V	Subspaces of Rn, dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices.	8

TEXTBOOKS/REFERENCE BOOKS:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course code	Course subject	L	T	P	Credits
BMH-154	**Fundamentals of Computer**	4	0	0	4

LEARNING OBJECTIVES:

1. To make the students understand and learn the basics of computer.
2. To make them familiar with the parts and functions of computer.
3. To learn the features of some emerging technologies.

LEARNING OUTCOMES:

5. Students will learn to transform between bases, including the creation, geometric connections, and the application of orthogonal and orthonormal bases.
6. Students will learn Fundamental Theorem of Arithmetic.

Unit	Contents	Lectures
I	Introduction to computer system, uses, types, History of Computer. Data Representation: Number systems and character representation, binary system. Human Computer Interface: Types of software, Operating system as user interface, utility programs.	9
II	Devices: Input and output devices, keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter	9

	Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks.	
III	Web Essentials: Clients, Servers and Communication: The Internet –Basic Internet protocols–The WWW, HTTP request message –response message, web clients web servers – case study. Introduction to Database and Database Users, Database Management System Concepts.	9
IV	Overview of Emerging Technologies: Bluetooth, History of Android, Introduction to Android Operating Systems, Android Development Tools. Introduction to Artificial Intelligence, Background and Applications, Cloud computing, big data, Data mining, mobile computing and embedded systems	9

TEXTBOOKS/REFERENCE BOOKS:

1. Text Books: 1. A. Goel, Computer Fundamentals, Pearson Education, 2010.

2. Reference Books: 1. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006.

3. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2002

Course code	Course subject	L	T	P	Credits
BMH-104	**Discrete Mathematics**	4	0	0	4

LEARNING OBJECTIVES:

The main objective of this course is to familiarize students with Discrete Mathematics concepts that are essential for solving advanced problems in Mathematics, Computer science and Engineering.

LEARNING OUTCOMES:

1. Understanding of basics of Discrete Mathematics and basics of computing.
2. Contribute Knowledge of Mathematical logic and concept of relation and function structure.
3. Contribute Knowledge of Big O Function and Generating function and recurrence relations.

Unit	Contents	Lectures
I	Propositional Logic: Propopsition logic, Statement, Truth Table, Conditional and Bi-Conditional Statements, Propositional functions, Tautology and contradictions, Equivalent statement. Low of Duality, Quantifiers, Arguments and Validity of Arguments. Proof by counter examples.	8

II	Sets, Operation of set, Power set finite and infinite sets. Venn Diagrams for union, intersection, Laws of Algebra of sets. Cartesian Product of sets. Relations, types of relations, Matrix of relation, Graph of relation. Ordering relation and equivalence relation. Functions, one to one, many one type of functions. Composite function and invertible functions, binary operation on the sets, composition table	8
III	Equivalence classes, Properties of Equivalence classes, Partitions, partially orders set. Hasse Diagram, Maximal and minimal elements, Lower and upper bounds of set. Dual of Poset, products of Posets, Lattices, Sublattices, Isomorphic lattices and bounded lattices.	8
IV	Discrete Numeric functions and Generating functions: Definition of Discrete Numeric functions, Sum of Numeric functions, Products of Numeric functions, Convolution of Numeric functions. Asymptotic Behaviour of Numeric functions. Big O- Notation, Generating functions. Solution of Combinatorial Problems using Generating functions. Solution of Recurrence relations by Generating functions.	8
V	Boolean Algebra: Definition of Boolean Algebra, Principle of Duality, Subalgebra, Isomorphic Boolean Algebra, Boolean Algebra as Lattices, Representation theorem for finite Boolean Algebra. Boolean functions, Minimization of Boolean functions. K- Maps.	8

TEXTBOOKS/REFERENCE BOOKS:

1. Discrete Mathematics: C. L. Liu, Tata McGraw Hill, 1986.
2. Discrete Mathematics with computer application: Tremble and Manohar, Tata McGraw Hill, 2002.
3. Discrete Mathematics and its applications: Kenneth H Rosen, Mc Graw- Hill Company 2012.
4. Discrete Mathematics: M K Gupta, Krishna Prakashan Media(P) Ltd Meerut.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
CE -110	**ENVIRONMETAL SCIENCE AND ECOLOGY**	**2**	**0**	**0**	**2**

LEARNING OBJECTIVES:

The aim of the course is to make everyone aware of environmental issues like continuing problems of pollution, loss of forest, solid waste disposal, and degradation of environment.

LEARNING OUTCOMES:

1. Understand fundamental terms related to environment and aware of environmental problems
2. Analyze the complexities of environmental problems and should know remedies available to them and implement them at their own level

Unit	**Contents**	**Lectures**

I	THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: Basic definitions related to environment; Scope, vis-à-vis environmental science and environmental engineering; a use of environmental degradation, atmospheric composition and associated spheres, habitat and climate; objective, goals and principals involved in environmental education, environmental awareness, Environmental ethics, environmental organization and their involvement.	6
II	**NATURAL RESOURCES:** Renewable and non-renewable resources; forest resources, over-exploitation, and deforestation / afforestation; water resources, impact of over-utilization of surface and ground water, floods, drought, conflicts over water, dams; mineral resources: dereliction of mines, environmental effects of extracting and using mineral resources; Food resources, modern agriculture and its impact, problem associated with fertilizer and pesticide, water logging, salinity ; energy resources, renewable, non-renewable energy sources, solar energy, wind energy, hydro energy, biomass energy, geothermal energy, nuclear energy and its associated hazards; land as a resource, land degradation, man induced landslides, soil erosion and desertification.	8
III	**ECOSYSTEMS:** Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids; characteristic features, structure and function of the following ecosystem -forest ecosystem, grassland ecosystem desert ecosystem and aquatic ecosystems.	6
IV	**BIODIVERSITY AND ITS CONSERVATION:** Bio-geographical classification of India; biodiversity at global, national and local levels, India as a mega-diversity nation, hot-spots of biodiversity; value of biodiversity-consumptive use, productive use, social, ethical aesthetic and option values; threats to biodiversity; conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.	7
V	**ENVIRONMENTAL POLLUTION: Causes, effects and control measures of** air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution; solid waste management, e-waste management; disaster management –floods, earthquake, cyclone and landslides.	8

TEXTBOOKS/REFERENCE BOOKS:

1. Kaushik, Anubha, and Kaushik, C.P., "Perspectives in Environmental Studies", 4th Edition New Age International Publishers, 2004
2. Agarwal, K.C., "Environmental Biology", 2nd Edition, Nidhi Publ. Ltd., Bikaner, 2001.
3. Bharucha Erach, "The Biodiversity of India", 2nd Edition, Mapin Publishing Pvt. Ltd., 2006.
4. Brunner R. C., "Hazardous Waste Incineration", 1st Edition McGraw Hill Inc., 1989.
5. Clark R.S., "Marine Pollution", 1st Edition Clanderson Press Oxford,1989
6. .Cunningham, W.P., Cooper, T.H. Gorhani, E. & Hepworth, M.T., Environmental Encyclopedia", 2nd Edition, Jaico Publ. House, 2001.
7. De, A. K., "Environmental Chemistry", 2nd Edition, Wiley Eastern, 1989

8. Jadhav, H. and Bhosale, V.M ., "Environmental Protection and Laws", 1st Edition, Himalaya Pub. House, Delhi, 1995.
9. Mckinney, M.L. and Schocl. R.M., "Environmental Science Systems & Solutions", 2nd Edition, Web enhanced edition, 1996.
10. Rao M.N. and Datta, A.K.,"Waste Water Treatment", 2nd Edition, Oxford & IBH Publ.Co., 1987.
11. Sharma B.K., "Environmental Chemistry", 2nd Edition, Goel Publ. House, Meerut, 2001
12. Trivedi R.K. and Goel, P.K., "Introduction to Air Pollution", 2nd Edition, Techno-science Publications, 1996 .

B.Sc. Hons (MATHEMATICS)

(3rd SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH- 201	**ORDINARY DIFFERENTIAL EQUATIONS**	4	0	0	4

LEARNING OBJECTIVES:

1. Identify essential characteristics of ordinary differential equations.
2. Develop essential methods of obtaining closed form solutions.

LEARNING OUTCOMES:

1. Distinguish between initial value problems and boundary value problems.
2. Solve standard constant coefficient nonhomogeneous ordinary differential equations by the methods of undetermined coefficients.

Unit	Contents	Lectures
I	Formulation of differential equations, Order and degree of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form.	9
II	Orthogonal trajectories: in Cartesian coordinates and polar coordinates. Self-orthogonal family of curves. Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous.	11
III	Method of variations of parameters. Method of undetermined coefficients. Reduction of order of a differential equation. Linear differential equations of second order: Reduction to normal form.	11

IV	Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations.	8
V	Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators x (d/dx) or t (d/dt) etc. Simultaneous equation of the form dx/P = dy/Q = dz/R. Total differential equations. Condition for Pdx + Qdy +Rdz = 0 to be exact. General method of solving Pdx + Qdy + Rdz = 0 by taking one variable constant. Method of auxiliary equations.	11

TEXTBOOKS/REFERENCE BOOKS:

1. B.Rai & D.P. Chaudhary: Ordinary Differential Equations; Narosa, Publishing House Pvt. Ltd.
2. D.A. Murray: Introductory Course in Differential Equations. Orient Longaman (India

Course code	Course subject	L	T	P	Credits
BMH -203	**Graph Theory**	4	0	0	4

LEARNING OBJECTIVES:

1. It has an aim to know about different types of graph.
2. To understand Shortest Path.
3. To understand the difference between tautology and contradiction

LEARNING OUTCOMES:

1. Students will able to learn applications of matrix in graph.
2. It will help to understand Networking.

Unit	Contents	Lectures
I	Definition, examples and basic properties of graphs, Subgraph, Incidence and Degree of vertex, pseudo graphs, complete graphs. Bi-partite graphs, isomorphism of graphs. Connected and Disconnected graphs and Components.	8
II	Operations on Graphs, Paths and circuits, Eulerian circuits. Hamiltonian cycles, the adjacency matrix, weighted graph., circuit matrix, fundamental circuits, circuit matrix of a Graph. Cut and cut set matrix of a Graph. Path matrix, Relation between $A_{f,}$, $B_{f,}$, $C_{f,}$	11
III	Trees and fundamental circuits: Trees, Properties of Trees, Pendent vertex of a Tree, Distance and center of Tree, Rooted and Binary Trees,	11

	Counting Trees, spanning trees, Weighted Graph, Finding all Spanning Trees of a Graph.	
IV	Planner and Dual Graphs, Combinatorial Geometric Graphs, Kurtowskis two Graphs, Travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.	8
V	Coloring, Covering and partitioning of Graphs: Chromatic Number, Chromatic Partitioning, Matchings Covering, Four Color problem. Directed and undirected Graphs, Directed paths and connectedness, Eulers Diagraph, Tree with Directed edges Matrix A, B, & C of a digraphs.	11

TEXTBOOKS/REFERENCE BOOKS:

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004
4. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH- 205	**REAL ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:

1. To describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. To comprehend rigorous arguments developing the theory underpinning real analysis

LEARNING OUTCOMES:

1. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
2. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.

Unit	Contents	Lectures
I	Algebraic and Order Properties of R, d-neighborhood of a point in R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals.	9
II	Limit points of a set, Isolated points, Derived sets, Examples of derived sets, Bolzano-Weierstrass theorem, Illustrations of Bolzano-Weierstrass theorem for sets. Idea of countable sets, uncountable sets and uncountability of R	8
III	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria.	8
IV	Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.	7
V	Infinite series, convergence and divergence of infinite series, Cauchy Criterion,Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.	8

TEXTBOOKS/REFERENCE BOOKS:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010

Course code	Course subject	L	T	P	Credits
BMH -207	**NUMBER THEORY**	4	0	0	4

LEARNING OBJECTIVES:

1. To identify certain number theoretic functions and their properties.
2. Students will understand the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem.
3. Students will solve certain types of Diophantine equations

LEARNING OUTCOMES:

1. Students will learn to apply mathematical concepts and principles to perform numerical and symbolic computations.
2. Students will use technology appropriately to investigate and solve mathematical and statistical problems.

Unit	Contents	Lectures
I	Divisibility, G.C.D. (greatest common divisors), L.C.M.(least common multiple) Primes, Fundamental Theorem of Arithemetic, prime counting function, statement of prime number theorem, Linear Diophantine equation in two variables	9
II	Goldbach conjecture, linear congruences, complete set of residues, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem and its converse. Number theoretic functions, The number of divisors and the sum of divisors of a natural number n (The functions d (n) and σ (n)), totally multiplicative functions.	11
III	Definition and properties of the Dirichlet product, Mobius function and Möbius inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.	11
IV	Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties.	8
V	Quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.	11

TEXTBOOKS/REFERENCE BOOKS:

1. **David M. Burton**, *Elementary Number Theory* (6th Edition), Tata McGraw-Hill Edition, Indian reprint, 2007.
2. **Neville Robinns,** *Beginning Number Theory* (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.

Course code	Course subject	L	T	P	Credits
BMH- 209	**Group Theory**	**4**	**0**	0	**4**

LEARNING OBJECTIVES:

1. Students will be able to understand the concept of group theory.
2. Understand the properties of homomorphism and isomorphism.

LEARNING OUTCOMES:

1. Explain the concept of group homomorphism and the application of these concepts
2. Be able to produce examples and counter examples illustrating the mathematical concepts presented in the course.

Unit	Contents	Lectures
I	Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.	9
II	Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.	8
III	Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.	8
IV	External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.	7
V	Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.	8

TEXTBOOKS/REFERENCE BOOKS:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Course code	Course subject	L	T	P	Credits
BMH-211	**Introduction of MATLAB**	0	0	4	2

1.Basic Operations

Write a MATLAB script to perform the following operations:

- Addition of two numbers
- Subtraction of two numbers
- Multiplication of two numbers
- Division of two numbers

2. Matrix Manipulations

Create a 3x3 matrix and perform the following operations:

- Transpose of the matrix
- Determinant of the matrix
- Inverse of the matrix

3. Vector Operations

Create two vectors and perform the following operations:

- Dot product
- Cross product
- Element-wise multiplication

4. Plotting a Sine Wave

Write a script to plot a sine wave for values from 0 to 2π.

5. Solving Linear Equations

Solve the following system of linear equations using MATLAB: $2x+3y=52x + 3y = 52x+3y=5$ $4x−y=14x - y = 14x−y=1$

6. Generating Random Numbers

Generate a 5x5 matrix of random numbers between 0 and 1.

7. Conditional Statements

Write a MATLAB script to check if a given number is even or odd.

8. Loops

Write a MATLAB script to print the first 10 Fibonacci numbers using a for loop.

9. Functions

Create a function in MATLAB that calculates the factorial of a number.

10. File I/O

Write a MATLAB script to read a matrix from a file, perform a transpose, and write the result to a new file.

11. Basic Statistics

Compute the mean, median, and standard deviation of a given set of numbers.

12. Image Processing

Read an image, convert it to grayscale, and display the original and grayscale images.

13. Polynomial Operations

Given a polynomial p(x)=2x3−4x2+3x−6p(x) = 2x^3 - 4x^2 + 3x - 6p(x)=2x3−4x2+3x−6, find its roots.

14. Symbolic Math

Use symbolic variables to solve the following equation in MATLAB: x2−5x+6=0x^2 - 5x + 6 = 0x2−5x+6=0

15. Curve Fitting

Fit a polynomial to the following set of data points: x=[1,2,3,4,5]x = [1, 2, 3, 4, 5]x=[1,2,3,4,5] y=[2.2,2.8,3.6,4.5,5.1]y = [2.2, 2.8, 3.6, 4.5, 5.1]y=[2.2,2.8,3.6,4.5,5.1] Plot the data points and the fitted curve.

Feel free to ask for detailed solutions or explanations for any o

B.Sc. Hons (MATHEMATICS)

(4th SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH -202	Operation Research- I	4	0	0	4

LEARNING OBJECTIVES:

1. Evaluate the computational performance of search, satisfaction, optimization and learning algorithms. Apply search, satisfaction, optimization and learning algorithms to real world problems.

LEARNING OUTCOMES:

2. Describe at an intuitive level the process of artificial intelligence and operations research: a real-time cycle of problem understanding, formulation, solution and implementation
3. Formulate simple reasoning, learning and optimization problems, in terms of the representations and methods presented.

Unit	Contents	Lectures
I	Operations Research (OR) and its Scope, Modelling in OR, Scientific Method in Operations Research, Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.	9
II	Introduction to artificial variables, two phase method, Big M method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual	11
III	Transportation problem and its mathematical formulation, North West corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem	11
IV	Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem	8
V	Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.	11

TEXTBOOKS/REFERENCE BOOKS:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programming,* Narosa Publishing House, New Delhi, 2002.

Course code	Course subject	L	T	P	Credits
BMH -204	**Theory of Real Functions**	4	0	0	4

LEARNING OBJECTIVES:

1. Students will be able to describe fundamental properties of continuous functions that lead to the formal development of real analysis.
2. Appreciate how abstract ideas and regions methods in mathematical analysis can be applied to important practical problems.

LEARNING OUTCOMES:

1. Demonstrate an understanding of limits ad how that are used in sequences, series and differentiation.
2. Construct rigorous mathematical proofs of basic results in real analysis.

Unit	Contents	Lectures
I	Limits of functions (ϵ-δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions.	9
II	Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.	11
III	Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem.	11
IV	Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to	8

	inequalities and approximation of polynomials, Taylor's theorem to inequalities.Cauchy's mean value theorem.	
V	Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln(1 + x), 1/ax+b and (1 +x)n	11

TEXTBOOKS/REFERENCE BOOKS:

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH -206	**PDE and its Applications**	4	0	0	4

LEARNING OBJECTIVES:

1. Introduce students to partial differential equations
2. Introduce students to how to solve linear Partial Differential with different methods

LEARNING OUTCOMES:

1. Classify partial differential equations and transform into canonical form.
2. Solve linear partial differential equations of both first and second order.

Unit	**Contents**	**Lectures**
I	Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations.	9
II	Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Derivation of Heat equation, Wave equation and Laplace equation.	11
III	Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.	11

IV	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form	8
V	Homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.	11

TEXTBOOKS/REFERENCE BOOKS:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers,* 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed.,Elsevier Academic Press, 2004.
4. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices,* Pearson Education, 2006.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH 208	**Numerical Methods**	**4**	**0**	**0**	**4**

LEARNING OBJECTIVES:

1. Derive appropriate numerical methods to solve algebraic and transcendental equations
2. Develop appropriate numerical methods to approximate a function

LEARNING OUTCOMES:

1. Solve an algebraic or transcendental equation using an appropriate numerical method
2. Approximate a function using an appropriate numerical method

Unit	**Contents**	**Lectures**
I	ERRORS AND APPROXIMATIONS, SOLUTION OF NONLINEAR EQUATIONS: Introduction to numbers and their accuracy; absolute, relative and percentage errors. Bisection method; Regular falsi method; secant method; fixed point iteration method; Newton- Raphson method; convergence criteria of methods.	9

II	SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS: Gauss elimination method; Gauss-Jordan method; UV factorization method; Jacobi's iteration method; Gauss-Seidal iteration method.	11
III	INTERPOLATION AND CURVE FITTING: Introduction to interpolation ; Newton's forward and backward interpolation formulae; Gauss's forward and backward interpolation formulae; Stirling formula; Lagrange interpolation; Newton's divided difference formula; Principle of least squares; curve fitting.	11
IV	NUMERICAL DIFFERENTIATION AND INTEGRATION: Numerical differentiation formulae: differentiation by using forward interpolation formula; backward interpolation formula; Stirling formula; Newton-Cotes formula for numerical integration: Trapezoidal rule; Simpson's rules; Boole's rule and Weddle's rule; Romberg' method.	8
V	NUMERICAL SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATION: Taylor series method; Euler method; Euler modified method; Runge kutta method; Milne's predictor - corrector method; Adams-Bashforth method for finding solution of differential equation.	11

TEXTBOOKS/REFERENCE BOOKS:

1. Grewal, B. S., "Numerical methods in Engineering and Science".
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007
3. Sastry, S.S., "Introductory Methods of Numerical Analysis".

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH 258	**Numerical Methods Lab**	**0**	**0**	**4**	**2**

List of Practical (Using any software)

(1) Bisection Method.

(2) Newton Raphson Method.

(3) Secant Method.

(4) Regulai Falsi Method.

(5) LU decomposition Method.

(6) Gauss-Jacobi Method.

(7) Ga uss-Siedel Method.

(8) Lagrange Interpolation or Newton Interpolation.

(9) Simpson's rule.

(10) Trapezoidal Rule

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH-254	**Operation Research -I** **MATLAB Lab**	**0**	**0**	**4**	**2**

MATLAB Programming

NAME OF EXPERIMENT:

1. Draw a 3X3 Matrix and Find its Eigen values and Eigen vectors.

2. Solve the differential Equation $\frac{dy}{dx} = 1 + xy$ by using R.K method of 1st and 2nd order.

3. Solve the differential Equation $\frac{dy}{dx} = \frac{y-x}{y+x}$ by using Euler's Method.

4. Evaluate the function by Newton's forward and backward Interpolation.

X	1	2	3	4	5
Y	1	4	9	16	25

5 . If a matrix $A=\begin{matrix}2 & 2 & 3\\ 1 & -1 & 0\\ 3 & 2 & 4\end{matrix}$ and $B=\begin{matrix}2 & 1 & 4\\ -1 & 4 & 0\\ 3 & 6 & 4\end{matrix}$ and matrix C is a unit matrix, check by MATLAB (Scilab) Coding i) Distributive law (ii) Associative law

(iii) Commutative law (iv) Addition of 3 matrices (v) AB and BC

6. Solve the system of linear equation

$$2x + y - 2z = -2\ ,3x - 2y + z = 2, -2x - 2y + 3z = 3$$

And find the reduced row echelon form.

7. Solve the differential Equation $f(x) = x^2$ by using Trapezoidal Rule.

8. Solve the differential Equation $f(x) = x^2$ by using Simpson's 1/3rd Rule.

9. Solve the differential Equation $f(x) = x^2 - 2x - 1$ by using Regula Falsi method and Newton Raphson method.

10. Declare the two matrices and find its Addition, Multiplication, and Subtraction and also find the determinant of each matrix.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH -210	**Multivariate Calculus**	4	0	0	4

LEARNING OBJECTIVES:

The understand how the value of a multivariable function changes as one of its independent variables is allowed to vary with all other variables fixed at constants.

LEARNING OUTCOMES:

1. Handle vectors fluently in solving problems involving the geometry of lines, curves, planes, and surfaces in space.
2. Visualize and draw graphs of surfaces in space.

Unit	**Contents**	**Lectures**
I	Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability.	9
II	Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange	11

	multipliers, constrained optimization problems, Definition of vector field, divergence and curl	
III	Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.	11
IV	Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.	8
V	Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.	11

TEXTBOOKS/REFERENCE BOOKS:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Pvt .Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001

B.Sc. Hons (MATHEMATICS)

(5th SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH- 301	**Ring Theory and Linear Algebra I**	4	0	0	4

LEARNING OBJECTIVES:

1. Students will have the capacity to work with the classes of rings and fields appearing in the course, particularly specific calculations around finite fields and polynomials.
2. Be able to produce examples and counter examples illustrating the mathematical concepts presented in the course.

LEARNING OUTCOMES:

1. Will be able to write the statements and proofs of important theorems and be able to explain the key steps in proofs, sometimes with variation.
2. Will be able to write the statements and proofs of important theorems and be able to explain the key steps in proofs, sometimes with variation

Unit	Contents	Lectures
I	Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring.	9
II	Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.	11
III	Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.	11
IV	Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.	8
V	Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.	11

TEXTBOOKS/REFERENCE BOOKS:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
5. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
6. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

Course code	Course subject	L	T	P	Credits
BMH -303	**Analytical Geometry**	4	0	0	4

LEARNING OBJECTIVES:

1.Model spatial problems with vectors, lines, planes, curves and surfaces in space.

2.The use of differentiation for vector-valued functions to compute tangent lines and also differentiation for multivariate functions to find extrema and rates of change.

LEARNING OUTCOMES:

1.This course is using iterated integrals to measure areas, compute volumes and find centres of mass.

2.Knwoledge of Two-dimensional transformations.

Unit	Contents	Lectures
I	**Unit 1:** Transformation of axes in two dimensions: Shifting of origin, rotation of axes, invariants.	12
II	**Unit 2:** Pair of Straight Lines: Joint equation of pair of straight lines and angle between them, Condition of parallelism and perpendicularity, Joint equation of the angle bisectors, Joint equation of lines joining origin to the intersection of a line and a curve	18
III	**Unit 3:** Circle: General equation of circle, Circle through intersection of two lines, tangents, normal, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, angle of intersection and orthogonality, power of a point w.r.t. circle, radical axis, co-axial family of circles, limiting points.	14
IV	**Unit 4:** Conic: General equation of a conic, tangents, normal, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, diameter.	12
V	**Unit 5:** Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola. Identification of conic in general second-degree equations.	15

TEXTBOOKS/REFERENCE BOOKS:

1. S. L. Loney: The Elements of Coordinate Geometry, Macmillan and Company, London, 2 nd Edition 2007.

2.P.K. Jain and Khalil Ahmad: A Text Book of Analytical Geometry of Two Dimensions, Wiley Eastern Ltd.,

Course code	Course subject	L	T	P	Credits
BMH 307	**Probability and Statistics**	4	0	0	4

LEARNING OBJECTIVES:

We will study about the Basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables. Provide the knowledge about discrete time Markov chain.

LEARNING OUTCOMES:

1. How to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions.
2. Discrete time Markov chains and methods of finding the equilibrium probability distributions.

Unit	Contents	Lectures
I	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments	9
II	Moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial	11
III	Continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions.	11
IV	Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance(from jmgf), linear regression for two variables.	8
V	Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states	11

TEXTBOOKS/REFERENCE BOOKS:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*,

7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.

Course code	Course subject	L	T	P	Credits
BMH- 309	**Riemann Integration and Series of Functions**	4	0	0	4

LEARNING OBJECTIVES:

1. To describe a regular partition of an interval, a Riemann sum for a function on a given interval (including the specific cases of left, right, and mid-point Riemann sums), and how they can be used to approximate area.
2. Compute specific Riemann sums for a function on a given interval.

LEARNING OUTCOMES:

1. Read and interpret an expression in sigma notation as the sum of a series of numbers.
2. Express Riemann sums for a function f(x) on a given interval using sigma notation, and identify a function and an interval which give rise to a given Riemann sum in sigma notation.

Unit	Contents	Lectures
I	Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions;	9
II	Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.	11
III	Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Improper integrals; Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions.	11
IV	Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.	8
V	Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.	11

TEXTBOOKS/REFERENCE BOOKS:

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

Course code	Course subject	L	T	P	Credits
BMH-311	**Metric space**	4	0	0	4

LEARNING OBJECTIVES:

3. Identify essential characteristics of Metric space.
4. Develop essential methods of obtaining closed form solutions.

LEARNING OUTCOMES:

3. Distinguish between initial value problems and boundary value problems.
4. Solve standard constant coefficient nonhomogeneous ordinary differential equations by the methods of undetermined coefficients.

Unit	Contents	Lectures
I	Basic Concept: Metric space definition and examples, Distance function Diameter in a Metric Space, Bounded and Unbounded metric space.	9
II	Open and closed ball, Neighborhood, Open set, Interior of set, Limit point of a set, Derived set, Closed set, Closure of a set, Subspaces, Dence set.	11
III	Sequences and subsequences of a metric space, convergent sequences in a metric space, cluster points of a sequence, Cauchy sequences in metric space, Definition of a complete metric space and examples and cantor s intersection theorem	11
IV	Continuity and uniform continuity in metric spaces: Continuous mappings, Sequential criterion and other characterization of continuity, Uniform continuity of composite functions, Homomorphism, Characterization of homomorphism.	8

TEXTBOOKS/REFERENCE BOOKS:

3. 1. M K Singal & A R Singal, Topics in Analysis II, 2017.
4. 2. S. Kumaresen, Topics of Metric Spaces, Narosa Publishing House, 2014.
5. 3. G F Simmons, Introduction to Topology, Tata Mc Graw Hill, 2004.

B.Sc. Hons (MATHEMATICS)

(6th SEMESTER)

LINGAYA'S VIDYAPEETH
Deemed-to-be-University u/s 3 of UGC Act 1956, Government of India

Course code	Course subject	L	T	P	Credits
BMH 302	**Operation Research- II**	4	0	0	4

LEARNING OBJECTIVES:

4. Evaluate the computational performance of search, satisfaction, optimization and learning algorithms. Apply search, satisfaction, optimization and learning algorithms to real world problems.

LEARNING OUTCOMES:

5. Describe at an intuitive level the process of artificial intelligence and operations research: a real-time cycle of problem understanding, formulation, solution and implementation for realistic non linear systems.
6. Formulate simple reasoning, learning and optimization problems, in terms of the representations and methods presented.

Unit	Contents	Lectures
I	Introduction of Matrices and operations on matrix, square matrix and inverse of matrix using Elementary row transformations. Linear combination of vectors, Linear Independent and linear dependent vectors. Convex set and convex combination. Hyperplane and hyperspheres. Convex functions. Local and Global Extrema. Quadratic forms. Simplex method.	9
II	Duality in LPP and applications, Dual Simplex method, Integer programming Problem, All- LPP Gomory constrains contraction method, Fractional cut method (Mixed integer programming), Branch and bound method. Application of Integer Programming. Revised Simplex Method.	9
III	Goal Programming, categorization of Goal programming. Formulation of Linear Goal Programming problem. Simplex method for Goal Programming, Parametric Linear Programming and Fractional Programming. Karmarkar Algorithm. Job Sequencing on n job 2 machine, m jobs n machines, Graphical method for Job sequencing. Dynamic programming, Solution of dynamic programming problems using classical method and Simplex method.	10
IV	Non- linear programming programing (NPLL): Formulation of NLPP, Constraints optimization with Equality constraints, Constraints optimization with inequality constraints. Saddle points problems, Saddle points and NLPP, Graphical solution of NLPP, Kuhn Tucker conditions with Non negative constraints, Quadratic Programming, Wolfes Modified Simplex method, Beale Method, Separable Programming.	9
V	Replacement Models: Introduction- Replacement of items that deteriorate with time- when money value is not counted and counted- Replacement	9

	of items that fail completely- Group Replacement. Recruitment and promotion problem, Equipment renewal Problem, Reliability and system failure rates, Computation of reliability of system architectures. Mean time between failure (MTBF).	

TEXTBOOKS/REFERENCE BOOKS:

1. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
2. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.
3. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.
4.Kanti Swarup, P. K. Gupta, Man Mohan. Operation Research, Sultan. Chand& Sons, New Delhi.

Course code	Course subject	L	T	P	Credits
BMH 304	**COMPLEX ANALYSIS**	4	0	0	4

LEARNING OBJECTIVES:

Students will understand the differentiation and integration of complex functions and know the tools and results of complex analysis including Cauchy's Theorem, Cauchy's integral formula, Liouville's Theorem, Laurent's expansion and the theory of residues.

LEARNING OUTCOMES:

1. Students will demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from complex analysis.
2. Students will demonstrate accurate and efficient use of complex analysis techniques.

Unit	Contents	Lectures
I	Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.	9
II	Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.	11
III	Antiderivatives, proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula. An extension of Cauchy integral formula, consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.	11

IV	Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series, uniqueness of series representations of power series.	8
V	Isolated singular points, residues, Cauchy's residue theorem, residue at infinity. Types of isolated singular points, residues at poles and its examples, definite integrals involving sines and cosines.	11

TEXTBOOKS/REFERENCE BOOKS:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, Complex analysis (2nd Edition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH -306	**Ring Theory and Linear Algebra II**	**4**	**0**	**0**	**4**

LEARNING OBJECTIVES:

1. Demonstrate understanding of the idea of a group, a ring and an integral domain, and be aware of examples of these structures in mathematics.
2. Appreciate the significance of unique factorization in rings and integral domains. To learn the basic terminology and results concerning abstract algebra

LEARNING OUTCOMES:

1. Students completing this course will be able to find the null space of a matrix and represent it
2. Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty.

Unit	**Contents**	**Lectures**
I	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests and irreducibility tests.	9
II	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests and irreducibility tests.	11
III	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear	11

	operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator	
IV	Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal Complements	8
V	Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem	11

TEXTBOOKS/REFERENCE BOOKS:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
5. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007

Course code	Course subject	**L**	**T**	**P**	**Credits**
BMH 350	**Operation Research II Lab**	**0**	**0**	**4**	**2**

List of Programs:

1. MATLAB program for Addition subtraction and Multiplication of Matrices.

2. MATLAB program for inverse of Matrices.

3. MATLAB for Manipulation of Matrices. Lower triangular part of a matrix, Upper triangular part of a matrix

4.MATLAB program for Vector cross product (dot: Vector dot product, Evaluate eigenvalues and eigenvectors)

5. MATLAB program for solving Linear Programming problem as integer solution.

6. MATLAB program for solution of Non-Linear programming problem.

7. Graphical solution of NLPP by using Matlab

8. Kuhn Tucker conditions with Non negative constraints,

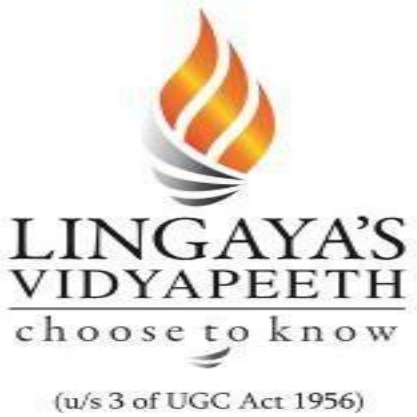
9. Quadratic Programming, Wolfes Modified Simplex method,

10. Beale Method, Separable Programming.

Total Credits B.Sc.(H) Mathematics=126

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)

SCHOOL OF BASIC & APPLIED SCIENCES (DEPARTMENT OF MATHEMATICS)

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**

PROGRAMME STRUCTURE
M.Sc. Mathematics

School : School of Basic and Applied Sciences	**Batch: 2024-2026**
Department: Mathematics	**Year: 1st**
Course: MSc 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**	**75**	**125**	**300**			**500**

Abbreviations:

PCC: Programme Core Courses
PEC: Programme Elective Courses
PROJ: Project
PDP: Personality Development Programme
L: Lecture
T: Tutorial
P: Practical

ABQ: Assignment Based Quiz
MSE: Mid Semester Examination
ESE: End Semester Examination
IP: Internal Practical
EXP: External Practical

School : School of Basic and Applied Sciences	**Batch: 2024-2026**
Department: Mathematics	**Year:1st**
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**	**75**	**125**	**300**			**500**

School : School of Basic and Applied Sciences	Batch: 2024-2026
Department: Mathematics	Year: 2nd
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 Theory 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**	**Research Methodology**	4	0	0	4	15	25	60	-	-	100
5	PCC	**MMA –209**	**Special Paper (Anyone)**	4	0	0	4	15	25	60	-	-	100
6	SEC	**MMA –251**	**MATLAB**	0	0	2	1	-	-	-	40	60	100
7	Project	**MMA –253**	**Synopsis Seminar**	0	0	1	1	-	-	-	40	60	100
8	Project	**MMA -255**	**Dissertation (**Literature Search and Review; Synopsis Submission**)**	0	0	4	2	-	-	-	40	60	100
			Total---->	**20**	**0**	**0**	**24**	**75**	**125**	**300**	**120**	**180**	**800**

MMA 209: Student can opt any one of under mentioned Special Paper (Anyone) courses as per Department academic policy.

Special Paper (Anyone)

(I) Special Function
(II) Fuzzy Sets and Applications
(III) Mechanics of Solids
(IV) Multivariate Analysis

School : School of Basic and Applied Sciences	Batch: 2024-2026
Department: Mathematics	Year: 2nd
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**	**Special Paper (Anyone**	**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---->	**12**	**0**	**15**	**20**	**45**	**75**	**180**	**40**	**60**	**400**

MMA 206: Student can opt any one of under mentioned Special Paper (Anyone) courses as per Department academic policy.

(I) Classical Mechanics

(II) Advanced Discrete Mathematics

(III) Mathematical Modeling

(IV) Theory of Field Extensions

SEMESTER-I

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:
3. Use group in solving physical problems.
4. Use ring functions.
5. Use polynomials and other special functions.
6. 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

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,	12

	fundamental properties of Dual problems, Complementary slackness, Dual simplex algorithm, Revised simplex method, Sensivity analysis.	
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**

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
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

SEMESTER-III

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 THEORY AND LEBESGUE 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	**8**

	its properties. Variance, Covariance, Moment generating function- Definitions and their properties.	
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	**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:**	**12**

	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.	
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- 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.

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 of Fuzzy Logic.	**11**

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.

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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

Course code	Course subject	L	T	P	Credits
MMA- 206(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 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.	**11**

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- 206(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.

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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. Chromatic number, Plane and planar graphs.	**11**
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-206(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.

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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 removal, Model with removal and immigration.	**9**
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,	**10**

	Arms race and battles: A model for diabetes mellitus, Richardson model for arms race, Lamechester combat model.	
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-206(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.

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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.

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.

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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- 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

Total Credits B.Sc.(H) Mathematics= 126

Total Credits M.Sc. Mathematics = 84