Syllabus

B.Sc. (Hons) Mathematics

THREE-YEARS FULL-TIME PROGRAMME

(Six-Semester Course)

2021-24

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+20**	**40**
End-Semester Practical Exam (External examination)	Viva-voce + Written exam + Practical record file	**20+25+15**	**60**

LINGAYA'S VIDYAPEETH

SCHEME OF STUDIES

SESSION: 2021-24

School : School of Basic and Applied Sciences	Batch: 2021-2024
Department: Mathematics	Year: First
Course: B.Sc. (Hons) Mathematics	Semester: 1

SN	Category	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	BS-101	Electricity and Magnetism	3	1	0	4	15	25	60	-	-	100
2	CC	BS-103	Algebra	3	1	0	4	15	25	60	-	-	100
3	GE	BS-105	Inorganic Chemistry	3	1	0	4	15	25	60	-	-	100
4	GE	BS-151	Physics Laboratory-I	0	0	3	2				40	60	100
5	GE	BS-155	Chemistry Laboratory-I	0	0	3	2				40	60	100
6	AECC	HSS-107	English and Communication Skills	2	0	0	2	15	25	60	-	-	100
			Total---->	**12**	**3**	**6**	**18**						**600**

Abbreviations:

CC:	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: 2021-2024
Department: Mathematics	Year: First
Course: B.Sc. (Hons) Mathematics	Semester: II

SN	Category	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	**BS-102**	Statistical Physics	3	1	0	4	15	25	60	-	-	100
2	CC	**BS-104**	Calculus	3	1	0	4	15	25	60	-	-	100
3	GE	**BS-106**	Organic Chemistry	3	1	0	4	15	25	60	-	-	100
4	GE	**BS-152**	Physics Laboratory-II	0	0	3	2				40	60	100
5	GE	**BS-154**	Chemistry Laboratory-II	0	0	3	2				40	60	100
6	AECC	**CE-108**	Environmental Science & Ecology	2	0	0	2	15	25	60	-	-	100
			Total---->	**11**	**3**	**6**	**18**						**600**

School : School of Basic and Applied Sciences	Batch: 2021-2024
Department: Mathematics	Year: Second
Course: B.Sc (Hons) Mathematics	Semester: III

SN	Category	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	CC	**BMH-201**	Ordinary Differential Equation	5	1	0	6	15	25	60	-	-	100
2	SEC	**BMH-203**	Graph Theory	2	0	0	2	15	25	60	-	-	100
3	CC	**BMH-205**	Real Analysis	5	1	0	6	15	25	60	-	-	100

4	DSC	**BMH-207**	Number Theory	5	1	0	6	15	25	60	-	-	100
5	CC	**BMH-209**	Group Theory-I	5	1	0	6	15	25	60	-	-	100
			Total--→	**22**	**4**	**0**	**26**						**500**

School : School of Basic and Applied Sciences	**Batch: 2021-2024**
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	CC	**BMH-202**	Group Theory-II	5	1	0	6	15	25	60	-	-	100
2	CC	**BMH-204**	Theory of Real Functions	5	1	0	6	15	25	60	-	-	100
3	CC	**BMH-206**	PDE and systems of ODE	5	1	0	6	15	25	60	-	-	100
4	CC	**BMH-208**	Numerical Methods	4	0	0	4	15	25	60	-	-	100
5	CC	**BMH-258**	Numerical Methods Lab	0	0	4	2				40	60	100
			Total--→	**19**	**3**	**4**	**24**						**500**

School : School of Basic and Applied Sciences	**Batch: 2021-2024**
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	CC	**BMH-301**	Multi Variate Calculus	5	1	0	6	15	25	60	-	-	100
2	CC	**BMH-303**	Ring Theory and Linear Algebra-I	5	1	0	6	15	25	60	-	-	100

3	DSC	**BMH-307**	Probability and Statistics	5	1	0	6	15	25	60	-	-	100
4	CC	**BMH-309**	Riemann Integration and series of functions	5	1	0	6	15	25	60	-	-	100
5	DSC	**BMH-311**	Analytical Geometry	5	1	0	6	15	25	60	-	-	100
			Total---->	**25**	**5**	**0**	**30**						**500**

School : School of Basic and Applied Sciences	**Batch: 2021-2024**
Department: Mathematics	**Year: Third**
Course: B.Sc (Hons) Mathematics	**Semester:6th**

SN	Category	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	DSC	**BMH-302**	Linear Programming	5	1	0	6	15	25	60	-	-	100
2	CC	**BMH-304**	Complex analysis	5	1	0	6	15	25	60	-	-	100
3	CC	**BMH-306**	Ring Theory and Linear Algebra-II	5	1	0	6	15	25	60	-	-	100
4	SEC	**BMH-350**	MATLAB	0	0	4	2				40	60	100
5	PROJ	**BMH-352**	Minor project/seminar/Industrial Training	0	0	12	6					100	100
			Total---->	**15**	**3**	**16**	**26**						**500**

B.Sc Hons (MATHEMATICS)

(1st SEMESTER)

Course code	Course subject	L	T	P	Credits
BS 101	**Electricity and Magnetism**	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	Vector Calculus : Differentiation of vectors, scalar and vector fields, conservative fields and potentials, line integrals, gradient of a scalar field, divergence of a vector field and divergence theorem, curl of a vector field and its physical significance, Stokes' theorem, combination of grad, div and curl.	8
II	Electric field and electric potential: Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson	14

	equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.	
III	Dielectric properties of matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.	10
IV	Magnetic field: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.	10
V	Electromagnetic induction & ballistic galvanometer: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Behavior of various substances in magnetic fields. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites.	10

TEXT BOOKS/REFERENCE BOOKS:

1. Mathematical Methods in the Physical Sciences: ML Boas, Wiley, 2002.
2. Introduction to Mathematical Physics: C Harper, Prentice Hall of India, 2004.
3. Electricity and Magnetism (Berkley, Phys. Course 2): EM Purcell, Tata McGraw Hill, 1981

Course code	Course subject	L	T	P	Credits
BS 103	**ALGEBRA**	3	1	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:

1. Students will learn to transform between bases, including the creation, geometric connections, and the application of orthogonal and orthonormal bases.
2. 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.	9
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.	7
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
BS 105	**INORGANIC CHEMISTRY**	3	1	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/Tutorials/Tutorials
I	**Atomic Structure:** Bohr's theory; its limitations and atomic spectrum of hydrogen atom; de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Sign of wave functions. Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	9
II	**Periodicity of Elements I:** s, p, d, f block elements, the long form of periodic table; Discussion of following properties with reference to s and p-block elements: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii (van der Waals) Ionic and crystal radii; Covalent radii (octahedral and tetrahedral)	12
III	**Periodicity of Elements II:** Ionization enthalpy; Successive ionization enthalpies and factors affecting ionization energy; Applications of ionization enthalpy; Electron gain enthalpy; trends of electron gain enthalpy. Electro negativity, Pauling's/Mulliken's/Allred Rachow's and Mulliken-Jaffé's electronegativity scales; Variation of electronegativity with bond order, partial charge, hybridization.	11
IV	**Chemical Bonding and Molecular Structure:** Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation; Born-Haber cycle and its application, Covalent bond: Lewis structure, Valence Bond theory, Bent's rule, concept of resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules; VSEPR theory, covalent character in ionic compounds, polarizing power and polarizability. Ionic character; Semiconductors and insulators, defects in solids.	13
V	**Oxidation-Reduction**: Redox reactions, Standard Electrode Potential and its application to inorganic reactions, Oxidation state, rules for the determination of oxidation states, electrochemical series, applications of electrochemical series.	7

TEXTBOOKS/REFERENCE BOOKS:

1. Lee, J.D., Concise Inorganic Chemistry, 5th edn, Blackwell Science, London.
2. Douglas, B.E. and McDaniel, D.H., *Concepts & Models of Inorganic Chemistry*,Oxford,1970
3. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
4. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2007.

Course code	Course subject	L	T	P	Credits
BS 151	**Physics Laboratory-I**	0	0	3	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.	Use of Vernier callipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometer, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level.
2.	Determination of 'g' by Kater's pendulum.
3.	To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
4.	Determination of modulus of rigidity by (i) dynamic method Maxwell's needle/Torsional pendulum (ii) Forced torsional oscillations excited using electromagnet
5.	Determination of coefficient of viscosity of a given liquid by Stoke's method. Study its temperature dependence.
6.	To study moment of inertia of a flywheel.
7.	Determination of modulus of rigidity by static method
8.	To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar.
9.	To study one dimensional collision using two hanging spheres of different materials
10.	Determination of height (of inaccessible structure) using sextant.
11.	Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
12.	Determine a high resistance by leakage method using Ballistic Galvanometer.
13.	To determine self-inductance of a coil by Rayleigh's method.
14.	To determine the mutual inductance of two coils by Absolute method.
15.	To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
16.	To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
17.	To determine the value of g using Bar Pendulum.
18.	To determine the height of a building using a Sextant.

TEXTBOOK/REFERENCE BOOKS:

1. A Text Book of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, Krishan Prakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

Course code	Course subject	L	T	P	Credits
BS 155	**CHEMISTRY LABORATORY-I**	0	0	3	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).

B.Sc Hons (MATHEMATICS)

(2nd SEMESTER)

Course code	Course subject	L	T	P	Credits
BS 102	**Statistical Physics**	4	0	0	4

LEARNING OBJECTIVES:

The main objective of this course is to familiarize students with Statistical Physics that are essential for solving advanced problems in Statistical an thermodynamics.

LEARNING OUTCOMES:

1. Understanding of basics of Statistical Physics.
2. Use of the Maxwell- Boltzmann statistics.
3. Use of the Bose-Einstein and Fermi-Dirac Statistics.

Unit	Contents	Lectures
I	Basic Ideas of Statistical Physics: Introduction, Basic ideas of probability and their applications, Macrostates and microstates, Effect of constraints on the system.	11
II	Distribution of n particles in two compartments, deviation from the state of maximum probability, Equilibrium state of a dynamic system, distribution of N distinguishable particles in unequal compartments, Division into cells, Phase space and its division into cells.	10
III	Maxwell-Boltzmann Statistics: Phase space and its division into cells. Three kinds of statistics and their basic approach. Maxwell-Boltzmann Statistics for an ideal gas: Volume in phase space, values of α and β. Experimental verification and graphical depiction of Maxwell-Boltzmann distribution of molecular speeds	11
IV	Isolated System: Micro canonical Ensemble, Closed System : Canonical Ensemble, Open System : Grand Canonical Ensemble Bose-Einstein Statistics : Need for quantum statistics, Bose-Einstein	11

	statistics and its application to Black body radiation, photon gas, deductions from Planck's law.	
V	Fermi-Dirac Statistics: Fermi-Dirac statistics and its application to electron gas, Fermi energy, comparison of M.B., B.E. and F.D. statistics	9

TEXTBOOKS/REFERENCE BOOKS:

1. Statistical Physics, Thermodynamics and Kinetic Theory: VS Bhatia, Vishal Pub. Co. Jalandhar, 2003
2. Introduction to Statistical Physics: Kerson Huang Taylor & Francis Inc. 2002
3. An Introduction to Statistical Mechanics and Thermodynamics: Robert H. Swendsen. Oxford University Press Inc. 2012.
4. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
5. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
6. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.

Course code	Course subject	L	T	P	Credits
BS 104	**CALCULUS**	3	1	0	4

LEARNING OBJECTIVES:

1. Understand the major problems of differential and integral calculus.
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	Limit & Continuity*:* Definition of the limit of a function. Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions.	9
II	Applications of Differentiation: Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates. Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves. Newton's method. Radius of curvature for pedal curves.	8

	Tangential polar equations. Centre of curvature. Circle of curvature. Chord of curvature, evolutes	
III	Tests for concavity and convexity. Points of inflexion. Multiple points. Extrema. Tracing of curves in Cartesian, parametric and polar co-ordinates. Reduction formulae.Rectification, intrinsic equations of curve.	8
IV	Partial Differentiation: Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable.	7
V	Double and triple integrals; Change of order in double integrals. Application of Integration: length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution.	8

TEXTBOOKS/REFERENCE BOOKS:

1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.
5. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
6. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
7. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Ltd. (Pearson Education), Delhi, 2007.

Course code	Course subject	L	T	P	Credits
BS 106	**Organic Chemistry**	3	1	0	4

LEARNING OBJECTIVES:

1. Differentiate chiral and achiral molecules.
2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
3. Identify the stereo centers in a molecule and assign the configuration as R or S.

LEARNING OUTCOMES:

1. To learn the involvement of reactive intermediates and understand their structure and reactivity.
2. To learn and understand the orbital interactions (Woodward Hoffmann rules) in concerted reactions.
3. To calculate optical purity and enantiomer excess,

Unit	**Contents**	**Lecture/Tutorials/Tutorials**

I	**Basics Of Organic Chemistry-I:** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.	13
II	**Basics Of Organic Chemistry-II:** Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.	10
III	**Stereochemistry:** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.	13
IV	**Chemistry of Aliphatic Hydrocarbons: (i) Carbon-Carbon sigma bonds:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.	9
V	**Chemistry of Aliphatic Hydrocarbons (ii) Carbon-Carbon pi bonds:** Mechanism of E1 and E2 reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). Diels-Alder reaction..	9

TEXTBOOKS/REFERENCE BOOKS:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. Pearson Education).
2. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005

Course code	Course subject	L	T	P	Credits
BS 152	**Physics Laboratory-II**	0	0	3	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 Cauchy's constants and resolving power of a given prism.

2.	To find the refractive index of a given liquid using a prism spectrometer.
3.	To determine the wavelength of sodium light using Newton's rings method.
4.	To find the resolving power and magnification of a telescope.
5.	To find the resolving power and magnification of a diffraction grating.
6.	To study hydrogen/Neon gas discharge tube spectrum using diffraction grating.
7.	To study temperature dependence of refractive index of organic liquid using Abbe's refractometer.
8.	To study the variation of specific rotation of sugar solution with concentration.
9.	To measure power distribution and divergence parameters of He-Ne and Semiconductor Lasers.
10.	Study of G.M. Counter characteristics. Measurements of Background radiation and alpha, beta and gamma rays using natural sources.
11.	To find the first ionization potential of mercury.
12.	To determine the value of Stefan's Constant of radiation
13.	Determination of mechanical equivalent of heat by Calendar and Barne's constant flow method.
14.	To measure the thermal conductivity and thermal diffusivity of a conductor.
15.	To determine thermal conductivity of a bad conductor disc (i) Lees and Chorlton method using steam heating and thermometers (ii) Advance kit involving constant current source for heating and thermocouples for temperature measurements.
16.	Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.

TEXTBOOKS/REFERENCE BOOKS:

1. A Text Book of Practical Physics: I Prakash, Ramakrishna, Kitab Mahal, 11th ed., 2011.
2. BSc Practical Physics: Geeta Sanon, R. Chand & Co., 1st ed., 2007.

Course code	Course subject	L	T	P	Credits
BS 154	CHEMISTRY LABORATORY-II	0	0	3	2

LEARNING OBJECTIVES:

The objective of the course is to present a theory of classical electrodynamics. Thus, Maxwell equations and their consequences are considered in detail. It is concerned with principles of the electromagnetic field theory and the description using Maxwell's equations.

LEARNING OUTCOMES:

Understanding of motion of charged particles in electromagnetic fields, principles of the special theory of relativity and invariance of Maxwell equations under the Lorentz transformation and there related problems.

S. No.	Practical Description
1.	**Preparation of the following inorganic compounds** (I) $VO(acac)_2$ (II) (II) Cis-$K[Cr(C_2O_4)_2(H_2O)_2$ (III) (III) $Na[Cr(NH_3)_2(SCN)_4]$ (IV) (IV) $K_3[Fe(C_2O_4)_3]$
2.	**Quantitative Analysis** (a) Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe, Ba-Cu etc. involving volumetric and gravimetric methods.
3.	**Spectrophotometric Determinations** 1. Ni by extractive Spectrophotometric method. 2. Fe by Job's method of continuous variations 3. Fe in vitamin tablets 4. Nitrite in water in colorimetric method.
4.	Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
5.	Determination of enthalpy of hydration of copper sulphate.

TEXTBOOKS/REFERENCE BOOKS:

1. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge.
2. Inorganic Synthesis, MC Graw Hill.
3. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
4. Standard methods of chemical analysis by W.W. Scaff, Technical Press.
5. Vogel's Qualitative Inorganic Analysis (revised), Orient Longman.

Course code	Course subject	L	T	P	Credits
CE 108	ENVIRONMETAL SCIENCE AND ECOLOGY	3	1	0	4

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 uses 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.	
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.	
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.	
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.	
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.	

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**	5	1	0	6

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**	2	0	0	2

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	Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, bi-conditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.	9
II	Propositional equivalence: Logical equivalences. Predicates and quantifiers. Introduction, Quantifiers, Binding variables and Negations.	11
III	Definition, examples and basic properties of graphs, pseudo graphs, complete graphs. Bi-partite graphs, isomorphism of graphs.	11

IV	Paths and circuits, Eulerian circuits. Hamiltonian cycles, the adjacency matrix, weighted graph.	8
V	Travelling salesman's problem, shortest path, Dijkstra's algorithm,Floyd-Warshall algorithm.	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**	5	1	0	6

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:

2. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
3. 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,	9

	Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals.	
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**	5	1	0	6

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 I**	5	1	0	6

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.

B.Sc Hons (MATHEMATICS)

(4^{th} SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH 202	**Group Theory II**	5	1	0	6

LEARNING OBJECTIVES:

1. This lecture course unit aims to introduce students to some more sophisticated concepts and results of group theory as an essential part of general mathematical culture and as a basis for further study of more advanced mathematics.
2. Provide knowledge of some fundamental results and techniques from the theory of finite groups

LEARNING OUTCOMES:

1. Verify group properties in particular examples
2. Understand and use the concept of conjugacy

Unit	Contents	Lectures
I	Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.	9
II	Characteristic subgroups, Commutator subgroup and its properties.Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups	11
III	Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.	11
IV	Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn.	8
V	p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for $n \geq 5$,non-simplicity tests.	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. 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 204	**Theory of Real Functions**	5	1	0	6

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 inequalities and approximation of polynomials, Taylor's theorem to inequalities.Cauchy's mean value theorem.	8
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	11

	expansions of exponential and trigonometric functions, ln(1 + x), 1/ax+b and (1 +x)n	

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 Systems of ODE**	5	1	0	6

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;	11

	Lagrange interpolation; Newton's divided difference formula; Principle of least squares; curve fitting.	
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 252	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) Gauss-Siedel Method.

(8) Lagrange Interpolation or Newton Interpolation.

(9) Simpson's rule.

(10) Trapezoidal Rule

B.Sc Hons (MATHEMATICS)

(5^{th} SEMESTER)

Course code	**Course subject**	**L**	**T**	**P**	**Credits**
BMH 301	**Multivariate Calculus**	5	1	0	6

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 multipliers, constrained optimization problems, Definition of vector field, divergence and curl	11
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

Course code	Course subject	L	T	P	Credits
BMH 303	**Ring Theory and Linear Algebra I**	5	1	0	6

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 305	**Probability and Statistics**	5	1	0	6

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**	5	1	0	6

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.

B.Sc Hons (MATHEMATICS)

(6th SEMESTER)

Course code	Course subject	L	T	P	Credits
BMH 302	**Linear Programming**	5	1	0	6

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 304	**COMPLEX ANALYSIS**	5	1	0	6

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**	5	1	0	6

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 operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator	11
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 352	**MATLAB**	**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.