LINGAYA'S VIDYAPEETH, FARIDABAD

CBCS of B.Sc. Hons.(Mathematics)program

Total Duration: 3 years (Six semesters)

2018-2019

Semester – I					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-114	Real Analysis	5-1-0	6	
2	BMA-115	Calculus	5-1-0	6	
3	BMA-117	Algebra	5-1-0	6	
4	EN-101A	English Communication (AECC-1)	2-0-0	2	
5	BPH-124	Mechanics	4-0-0	4	
6	BPH-174	Mechanics Lab	0-0-3	2	
		Total	**27Hours**	**26**	

Semester – II					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-113	Ordinary Differential Equations	5-1-0	6	
2	BMA-119	Group Theory-I	5-1-0	6	
3	BMA-120	Theory of Real Functions	5-1-0	6	
4	BCH-115	Physical Chemistry (GE-2)	3-1-0	4	
5	CEA-101A	Environmental Science & Ecology(AECC-2)	2-0-0	2	
6	BCH-165	Physical Chemistry Lab	0-0-4	2	
7	PD-192 A	Hobby Club	0-0-2	2	
		Total	**32 Hours**	**28**	

Semester – III					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-222	PDE and systems of ODE	5-1-0	6	
2	BMA-223	Logic and sets(SEC-1)	3-1-0	4	
3	BMA-225	Riemann Integration and series of functions	5-1-0	6	
4	BMA-226	Ring Theory and Linear Algebra-I	5-1-0	6	
5	BCS-201	Web Designing	3-0-0	3	
6	BA-2312	Entrepreneurship Development	3-0-0	3	
		Total	**28Hours**	**28**	

Semester – IV					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-229	Numerical Methods	3-1-0	4	
2	BMA-224	Ring Theory and Linear algebra II	5-1-0	6	
3	BMA-225	Analytical Geometry (DSE-1)	5-1-0	6	
4	BMA-227	Graph Theory (SEC-2)	3-1-0	4	
5	BMA-279	Numerical Methods Lab	0-0-2	2	
6	BA-264A	Managerial Skills (GE-4)	3-0-0	3	
7	PD-293	PDP/Interpersonal Skills	2-0-0	2	
		Total	**27Hours**	**27**	

Semester – V					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-325	Multi Variate Calculus	5-1-0	6	
2	BMA-326	Group Theory II	5-1-0	6	
3	BMA-328	Probability and Statistics(DSE 2)	4-1-0	5	
4	BMA-329	Metric space and Complex analysis	5-1-0	6	
5	PD-392	PDP/Interpersonal Skills	2-0-0	2	
		Total	**25Hours**	**25**	

Semester – VI					
Sr. No.	**Paper Code**	**Subject**	**L-T-P**	**Credits**	
1	BMA-331	Linear Programming (DSE 3)	5-1-0	6	
2	BMA-332	Mechanics (DSE 4)	4-1-0	5	
3	BMA-333	Major project/seminar/Industrial Training	0-0-10	10	
		Total	**21Hours**	**21**	

Lingaya's Vidyapeeth

MATHEMATICS

B.Sc (Hons) -1st SEMESTER

Course code	Course title	L	T	P	Credits
BMA-114	REAL ANALYSIS	5	1	-	6

Course 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

UNIT-1: 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. **[15]**

UNIT-2: 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 **[14]**

UNIT-3: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria. **[15]**

UNIT-4: Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion. **[15]**

UNIT-5: 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. **[18]**

TEXT BOOKS/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 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.

Course code	Course title	L	T	P	Credits
BMA-115	**CALCULUS**	5	1	-	6

Course 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.

UNIT-1: Limit & Continuity *:*The real line and its geometrical representation; *e-δ* treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions. **[12]**

UNIT-2: Differentiability: Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms. **[15]**

UNIT-3: Applications of Differentiation *:* Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates. **[15]**

UNIT-4: 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. **[17]**

UNIT-5: 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. **[15]**

TEXT BOOKS/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.

8. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

Course 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.

Course code	Course title	L	T	P	Credits
BMA-117	**ALGEBRA**	5	1	-	6

Course 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.

UNIT-1: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. **[12]**

UNIT- 2: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. **[20]**

UNIT- 3: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. **[15]**

UNIT -4:Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. **[12]**

UNIT - 5: Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices.

[15]

TEXT BOOKS/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 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

Course code	Course title	L	T	P	Credits
EN-101A	ENGLISH COMMUNICATION	2	0	0	2

Course Objectives:
1) Discuss and respond to content of a reading or listening passage 2) Use communication strategies to participate in group and class discussions

UNIT-1: Communication and its elements: An introduction to the need of communication competency; Role of vocabulary in effective communication**;** Word formation; A set of selected 50 synonyms, antonyms, homonyms & homophones; suffixes & prefixes **[5]**

UNIT 2: Listening and Reading Skills: Listening comprehension & reading comprehension; Listening to recorded speeches, TV News and other audio materials to test listening comprehension with given exercises **[7]**

UNIT 3: Writing Skills: Ad Creation; Slogan making; Picture composition; Expanding hints, proverbs; Movie review. **[6]**

UNIT 4: Letter writing: Types of letter writing; Structure & Lay out; Leave application; Letter of enquiry & response with respect to educational & official matters; Informal letter expressing or discussing social or educational issues. **[6]**

UNIT5: Spoken Skills: Introduction to oral communication; Importance of Pronunciation; Importance of phonetics; Usage of Phonetics; Types of Conversation; Strategies for effective conversation for social and official interaction; Developing conversation on topics of current importance. Soft Skills Non-verbal Importance of Body Language and its usage to communicate better. **[6]**.

	Course outcomes:
1.	Interact with academic content: reading, writing, listening, speaking;
2.	Demonstrate ability to think critically
3.	Utilize information and digital literacy skills

Course code	Course title	L	T	P	Credits
BPH-124	Mechanics	4	0	0	4

Course Objectives:

- To acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.
- To be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
- To be able to make approximate judgments about optical and other wave phenomena when necessary.
- To acquire skills allowing the student to organize and plan simpler laboratory course experiments and to prepare an associated oral and written report

Unit-1: Wave Optics-I : (10 Lectures)

Interference: Interference of light and its necessary conditions, path & Phase difference for reflected & transmitted rays, Interference in thin films (parallel and wedge shaped film), Newton's rings.
Diffraction: Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power, Rayleigh's criterion and resolving power of grating.

Unit-II Fundamentals of Dynamics: (10 Lectures)

Reference frames. Inertial frames; Galileantransformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.
Non-inertial frames and fictitious forces. Uniformly rotatingframe. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit-III Special Theory of Relativity: (10 Lectures)

Michelson-Morley Experiment and its outcome.Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. **(10 Lectures)**

Unit-IV Work Energy and Collisions: (10 Lectures)

Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Unit-V Magnetic & Superconducting Properties: (10 Lectures)

Magnetization, Origin of magnetic moment, Dia, para and ferro magnetism, Langevin's theory for diamagnetic material, Applications of Magnetism.
Superconductors: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Temperature dependence of critical field, Type I and Type II superconductors. Applications of Superconductors.

TEXT BOOKS/REFERENCE BOOKS:

- *An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.*
- *Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.*

- *Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.*
- *Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.*
- *Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education*
- *Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.*
- *University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.*

Additional Books for Reference

- *Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000*
- *University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley*
- *Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning*
- *Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.*

Course Objectives:
• To acquire skills allowing the student to identify and apply formulas of mechanics using course literature • To be able to make approximate judgement about waves and mechanics phenomenon when necessary • To acquire skill allowing the student to organize and plan simpler laboratory course and experiments to prepare and associated oral and written report.

Course code	Course title	L	T	P	Credits
BPH-174	**Mechanics**	**0**	**0**	**3**	**2**

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine "**g"** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Note: Each student is required to perform at least seven experiments.

TEXT BOOKS/REFERENCE BOOKS

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

Lingaya's Vidyapeeth

MATHEMATICS

B.Sc (2nd SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-113	ORDINARY DIFFERENTIAL EQUATIONS	5	1	-	6

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

UNIT-1: Geometrical meaning 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. **[12]**

UNIT-2: 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 .

[15]

UNIT-3: 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. **[14]**

UNIT-4: Transformation of the equation by changing the dependent variable/ the independent variable. Solution by operators of non-homogeneous linear differential equations. **[15]**

UNIT-5: 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. **[18]**

TEXT BOOKS/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 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.

Code	Name	L-T-P	Credits
BMA-119	**Group Theory I**	**5-1-0**	**6**

Course Objectives:

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

Unit-1: Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. **[15]**

Unit-2: 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. **[15]**

Unit-3: 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. **[15]**

Unit-4: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. **[15]**

Unit-5: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems. **[15]**

Books Recommended

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

Course code	Course title	L	T	P	Credits
BMA-120	**Theory of Real Functions**	5	1	-	6

Course 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.

Unit-1: Limits of functions ($\epsilon - \delta$ 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. **[16]**

Unit-2: 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. **[15]**

Unit-3: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. **[11]**

Unit-4: 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. **[18]**

Unit-5: 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 $(1 + x)^n$ **[17]**

Books Recommended

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 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.

Course code	Course title	L	T	P	Credits
BCH-115	**PHYSICAL CHEMISTRY II**	3	1	-	4

Course Objectives:
1) Here in this syllabus we start learning with aspects of thermochemistry and thermodynamics, it become easy to understand the aspect of thermodynamic behavior of chemical reaction and their direct indirect influence on chemical activity after the study. 2) We also learn the theory of Chemical equilibrium and their different aspect of forward and backward reactions. Student may also able to understand the colligative properties of any chemical systems.

UNIT-1: THERMOCHEMISTRY-I:

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 van der Waals) under isothermal and adiabatic conditions. **[8]**

Unit-II THERMOCHEMISTRY-II

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: 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. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

[10]

Unit-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.

[8]

Unit-IV CHEMICAL EQUILIBRIUM:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. 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 K_p , K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase. **[10]**

Unit-V SOLUTIONS AND COLLIGATIVE PROPERTIES:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. 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 of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution. **[10]**

TEXT BOOKS/REFERENCE BOOKS:

- Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

Course outcomes:	
1.	On finishing these modules of chemistry we are able to differentiate colligative properties of solution like elevation of boiling point, depression of freezing point with relatively lowering the vapor pressure.

2.	Its also easy to understand thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Course code	Course title	L	T	P	Credits
BCH-165	**PHYSICAL CHEMISTRY LAB-II**	-	-	4	2

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubilityΔ of benzoic acid in water and determination of H.

Any other experiment carried out in the class.

Course code	Course title	L	T	P	Credits
CEA-101A	**ENVIRONMETAL SCIENCE AND ECOLOGY**	2	0	0	2

Course Objectives:

1) 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.
2) Issues like economic productivity and national security, global warming, the depletion of ozone layer and loss of biodiversity are other serious concerns before the mankind.

UNIT-1: 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.

UNIT-2:. 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.

UNIT-3: 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.

UNIT-4: 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.

UNIT-5: 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.

TEXT BOOK/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

Course 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

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MATHEMATICS

B.Sc (3rd SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-222	**PDE and Systems of ODE**	5	1	-	6

Course Objectives:

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

Unit-1: 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. **[15]**

Unit 2: 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. **[14]**

Unit 3: Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms. **[15]**

Unit-4: 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 **[15]**

Unit-5: 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. **[15]**

Books Recommended

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

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MATHEMATICS

B.Sc (3rd SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-223	**Logic and Sets**	3	1	-	4

Course Objectives:

1.)Students will be able to explain the concepts of sets, relations and functions with a counter example.

2.)To understand the difference between tautology and contradiction.

Unit 1: Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. **[15]**

Unit 2: Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. **[14]**

Unit 3: Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finiteand infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standardset operations. Classes of sets. Power set of a set. **[15]**

Unit 4: Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.. **[15]**

Unit 5:Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, nary relations. **[15]**

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Course outcomes:	
1.	Students can formalise first-order properties with formulas of predicate logic.
2.	Students can prove simple first-order properties about sets, relations and functions using calculation style reasoning

Course code	Course title	L	T	P	Credits
BMA-225	**Riemann Integration and Series of Functions**	5	1	-	6

Course 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.

Unit 1: 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; **[15]**

Unit 2: Riemann integrability of monotone and continuous functions, Properties of theRiemann integral; definition and integrability of piecewise continuous and monotone functions. **[14]**

Unit 3: 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. **[15]**

Unit 4: 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. **[15]**

Unit 5: 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. **[15]**

Books Recommended

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 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.

Course code	Course title	L	T	P	Credits
BMA-226	**Ring Theory and Linear Algebra I**	5	1	-	6

Course 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.

Unit 1:Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. **[14]**

Unit 2: Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. **[15]**

Unit 3: Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients. **[15]**

Unit 4: Vector spaces , subspaces, algebra of subspaces, quotient spaces , linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. **[15]**

Unit 5: 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. **[15]**

Books Recommended:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., PrenticeHall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
8. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
9. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

Course 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.	Facility with the ring homomorphisms and presentations, and the application of these in order to describe aspects of the intrinsic structure of rings ,both abstractly and in specific examples

Course code	Course title	L	T	P	Credits
BCS-201	**WEB DESIGNING**	3	0	0	3

Course Objectives:
1) Understand the principles of creating an effective web page, including an in-depth consideration of information architecture. 2) Become familiar with graphic design principles that relate to web design and learn how to implement these theories into practice.

UNIT – 1 : INTRODUCTION TO INTERNET:

World Wide Web and concepts of website, web pages etc. Client – Server Architecture, The idea of hypertext and hyper media: how the web works: HTTP, HTML and URLs; how the browser works: MIME types, plug-ins and helper applications, standards, Introduction to HTML, XML, XHTML and the W3C. **[10]**

UNIT – 2 : HYPERTEXT MARKUP LANGUAGE:

HTMLS: The anatomy of an HTML document; marking up for structure and style: basic page markup, ordered and unordered list, Structuring content with HTML using natural divisions, Marquee text with or without background with attributes, Working with Links Internal Links: Anchor Link, Email Link; embedding images, table creation: Table attributes Colspan, Rowspan, Table Border, Align, Valign, Table background image, Nesting tables, Frames and Nesting, iframes, forms, Semantic elements of HTMLS, Media tags in HTMLS.

[8]

UNIT – 3 : CASCADING STYLE SHEET:

Introduction to Cascading Style Sheet: Selector, Declaration and declaration block. Types of CSS – Inline and Internal style specifications within HTML; external linked style specification using CSS, page and site design considerations. Types of Selector:

Universal, Class and ID Selector, Building & Applying Class Selectors, ID Selector using Div Tags and span tag. **[8]**

UNIT – 4 : CLIENT SIDE PROGRAMMING:

Introduction to JavaScript syntax: output, Comments, variables, functions, operators, conditions, switch, loop. Java1Script object model: Window, Location and History object

model; HTML DOM: Introduction to DOM: methods, event handling, navigation, Forms validation. **[10]**

UNIT – 5 : TESTING WEB APPLICATION :

Introduction, Fundamentals, Terminology, Quality characteristics, test objectives, test levels, Test Methods and Techniques, Link Testing, Browser Testing, Usability Testing Load, stress and continuous testing; Testing Security; Test automation; Benefits and drawbacks of automation testing. **[12]**

TEXT BOOKS/REFERENCE BOOKS:

Course outcomes:	
1.	Employ fundamental computer theory to basic programming techniques.
2.	Use fundamental skills to maintain web server services required to host a website.

Course code	Course title	L	T	P	Credits
BA-2312	ENTREPRENEURSHIP DEVELOPMENT	3	0	-	3

Course Objectives:
1. To educate people on the upsides and downsides of entrepreneurship 2. Entrepreneurship development programs are intended to shine a light on enterprise responsibility

UNIT-1: Introduction: The Entrepreneur: Definition, Emergence of Entrepreneurial Class; Theories of Entrepreneurship.

[5]

UNIT-2: Promotion of a Venture: Opportunity Analysis; External Environmental Analysis Economic, Social and Technological; Competitive factors; Legal requirements of establishment of a new unit and Raising of Funds; Venture Capital Sources and Documentation Required.

[9]

UNIT-3: Entrepreneurial Behaviour: Innovation and Entrepreneur; Entrepreneurial Behaviour and Psycho-theories, Social responsibility.Entrepreneurial Development Programmes (EDP): EDP, Their Role, Relevance and Achievements; Role of Government in Organizing EDP's Critical Evaluation.

[12]

UNIT-4: Role of Entrepreneur: Role of an Entrepreneur in Economic Growth as an Innovator, Generation of Employment Opportunities, Complimenting and Supplementing Economic Growth, Bringing about Social Stability and Balanced Regional Development of Industries: Role in Export Promotion and Import Substitution, Forex Earnings.

[14]

TEXT BOOKS/REFERENCE BOOKS:

1. Hisrich, Robert and Peters, Michael, (2002), Entrepreneurship, 5thEdition, McGrawHill Education.
2. Charantimani, (2006), Entrepreneurship Development and Small Business Enterprise, 1stedition, Pearson Education.
3. Chandra, Ravi, (2003), Entrepreneurial Success: A Psychological Study,

Sterling Publication Pvt. Ltd., New Delhi.
4. Balaraju, Theduri, (2004), Entrepreneurship Development: An Analytical Study, Akansha Publishing House, New Delhi.
5. David, Otes, (2004), A Guide to Entrepreneurship, Jaico Books Publishing House, Delhi.
6. Kaulgud, Aruna, (2003), Entrepreneurship Management, Vikas Publishing House, Delhi.

Course outcomes:	
1.	Students will be able to understand the basic development of entrepreneurship as a profession.
2.	Students will be able to have a basic knowledge of human resource management for small business

Lingaya's Vidyapeeth

MATHEMATICS

B.Sc (4th SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-**229**	**Numerical Methods**	3	1	-	4

Course Objectives:

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

UNIT-1. 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. **[15]**

UNIT-2. SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS : Gauss elimination method; Gauss-Jordan method; UV factorization method; Jacobi's iteration method; Gauss-Seidal iteration method . **[14]**

UNIT-3. 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. **[15]**

UNIT-4. 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. **[15]**

UNIT-5. 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. **[15]**

BOOKs Recommended:

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".

4) Curtis F "Applied Numerical Analysis".**Books Recommended**

5) Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

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

Course code	Course title	L	T	P	Credits
BMA-224	**Ring Theory and Linear Algebra II**	5	1	-	6

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

Unit 1: Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests. **[15]**

Unit 2: Eisenstein criterion,unique factorization in Z[x]**.** Divisibility in integral domains, irreducibles, primes, uniquefactorization domains, Euclidean domains. **[12]**

Unit 3: 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. **[18]**

Unit 4: Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal Complements. **[14]**

Unit 5: 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. **[16]**

TEXT BOOKS/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 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.

Course code	Course title	L	T	P	Credits
BMA-225	**Analytical Geometry**	5	1	-	6

Course Objectives:
Model spatial problems with vectors, lines, planes, curves and surfaces in space. 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. This course is use iterated integrals to measure areas, compute volumes and find centers of mass

Unit 1: Transformation of axes in two dimensions: Shifting of origin, rotation of axes, invariants. **[12]**

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]**

Unit 3: Circle : General equation of circle, Circle through intersection of two lines, tangents, normals, 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]**

Unit 4: Conic : General equation of a conic, tangents, normals, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, diameter. **[12]**

Unit 5: Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola. Indentification of conic in general second degree equations. **[15]**

TEXT BOOKS/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., 1999.

3. Erwin Kreyszig : Advanced Engineering Mathematics, John Wiley & Sons,1999.
Gorakh Prasad and H.C. Gupta : Text Book on Coordinate Geometry, Pothishala Pvt. Ltd., Allahabad, 1955

Course outcomes:	
1.	Construct and apply symbolic and graphical representations of functions
2.	Model real-life problems mathematically
3.	Use technology appropriately to analyze mathematical problems

Course code	Course title	L	T	P	Credits
BMA-227	**Graph Theory**	3	1	-	4

Course Objectives:
1) It has a aim to know about different types of graph. 2) To understand Shortest Path.

Unit1: Definition, examples and basic properties of graphs, pseudo graphs, complete graphs. **[10]**

Unit 2: Bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits. **[9]**

Unit-3:Hamiltonian cycles, the adjacency matrix, weighted graph,. **[11]**

Unit4:travelling salesman's problem ,shortest path, Kruskal Algorithm, **[9]**

Unit-5: Dijkstra's algorithm,Floyd-Warshall algorithm, Prim's Algorithm **[9]**

Books Recommended :

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

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

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MATHEMATICS

B.Sc (4th SEMESTER)

Code	Name	Credits(2)
BMA-279	**Numerical Methods Lab**	0-0-2

List of Practicals (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

Course code	Course title	L	T	P	Credits
BA-264A	**MANAGERIAL SKILLS**	3	0	0	3

Course Objectives:
1. To facilitate students' understanding of their own managerial skills. 2. To improve communication skills. 3. To learn from the management experience of others. 4. To develop and learn about goals specific to the students of this class

UNIT-1

Skill Development - Writing Business Letter, Official letters, 7C's & 4'S in Communication , Report writing , Skills, Presentation Skills , Communication : Concept, Types , process, barriers, making Communication effective.

Managerial creativity- Business Process Re-engineering - Concept , Process, Redesign, BPR, experiences in Indian Industry , Total Quality Management(TQM) - Concept , Systems model of Quality, Deming's approach, TQM as a business Strategy . **[10]**

UNIT-2

Technology led development- Knowledge Management (KM)- What , why, how, of Knowledge Management , KM process , approach, strategies, tools. E-commerce- Ideology, methodology, classification by application /nature of transactions , Driving Forces of EC, Impact of EC, Scope **[8]**

UNIT-3

Leadership for managers - Concept , Traits, Styles, Types of leadership, Leadership for managers-varied case studies for identifying and imbibing leadership attributes.

Selling & Negotiation Skills-Types of Negotiation , Negotiation Strategies ,Selling skills – Selling to customers , Selling skills – Body language, Conceptual selling, Strategic selling

[10]

UNIT-4

Conflict Management- Conflict Management - Types of conflicts and Conflict Management, Coping strategies and Conflict Management, Conflict Management Styles

[10]

UNIT-5

Positive thinking

Attitudes , Beliefs, Positive thinking – Martin Seligman's theory of Learned Helplessness , Learned Optimism, Case Studies and Presentations **[10]**

References

1.Stoner, Freeman , Gilbert Jr. : Management (Pearson education)

2.Kootz,O'Donnell , Weighrich : Essentials of Management

3.Michael , J. Stahl : Management -Total Quality in a global environment (Blackwell Business)

4.Newman , Warren and Summer : The Process of Management , Concept, Behaviour & Practice.

Course outcomes:	
1.	Manage the selection and initiation of individual projects and of portfolios of projects in the enterprise.
2.	Conduct project planning activities that accurately forecast project costs, timelines, and quality. Implement processes for successful resource, communication, and risk and change management.

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B.Sc(H) Mathematics (V- SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-325	**Multivariate Calculus**	5	1	-	6

Course Objectives:
The goal of this chapter is to see that many quantities in various scientific fields depend on more than one variable: the strength of the gravitational force between two bodies depend on their masses and their distance apart. 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.

UNIT-1: Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. **[12]**

UNIT-2: 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. **[14]**

UNIT-3: Double integration over rectangular region, double integration over non-rectangular region,Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped andsolid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. **[18]**

UNIT-4: Change of variables in double integrals and triple integrals. Line integrals, Applications of lineintegrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields,independence of path. **[12]**

UNIT-5: Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem. **[16]**

TEXT BOOKS/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 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.

Course code	Course title	L	T	P	Credits
BMA-326	**Group Theory II**	5	1	-	6

Course Objectives:
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. Provide knowledge of some fundamental results and techniques from the theory of finite groups

UNIT-1: Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. **[14]**

UNIT-2: 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. **[16]**

UNIT-3: Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.. **[17]**

UNIT-4: Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn. **[12]**

UNIT-5: *p*-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n ≥ 5,non-simplicity tests.. **[14]**

TEXT BOOKS/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 outcomes:	
1.	Verify group properties in particular examples
2.	Understand and use the concept of conjugacy

Course code	Course title	L	T	P	Credits
BMA-329	**Metric Spaces and Complex Analysis**	5	1	-	6

Course Objectives:
Students will have been introduced to point-set topology and will know the central importance of complex variables in analysis. Students will have grasped a deeper understanding of differentiation and integration in this setting and will 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

Unit 1: Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separablespaces. **[17]**

Unit 2: Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem.Connectedness, connected subsets of R. **[14]**

Unit 3: 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. Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions. **[15]**

Unit 4: Definite integrals of functions. Contours ,Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.Liouville's theorem and the fundamental theorem of algebra. **[15]**

Unit 5: Convergence of sequences andseries, Taylor series and its examples.Laurent series and its examples, absolute and uniform convergence of power series. **[12]**

TEXT BOOKS/REFERENCE BOOKS:

1. Satish Shirali and Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag, London, 2006.
2. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.
4. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
5. Joseph Bak and Donald J. Newman, *Complex Analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

Course outcomes:	
1.	Explain the fundamental concepts of real analysis and their role in modern mathematics and applied contexts
2.	Demonstrate accurate and efficient use of complex analysis techniques.

Course code	Course title	L	T	P	Credits
BMA-328	**Probability and Statistics**	4	1	-	5

Course 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 .

Unit 1: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments. **[8]**

Unit 2: Moment generating function, characteristic function, discrete distributions: uniform, binomial,Poisson, geometric, negative binomial. **[10]**

Unit 3: Continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions. **[11]**

Unit 4: 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. **[08]**

Unit 5: 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, classificationof states **[12]**

TEXT BOOKS/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.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

Course 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
3.	How to translate real-world problems into probability models

Lingaya's Vidyapeeth

B.Sc(H) Mathematics (VI- SEMESTER)

Course code	Course title	L	T	P	Credits
BMA-331	**Linear Programming**	5	1	-	6

Course Objectives:
1. Evaluate the computational performance of search, satisfaction, optimization and learning algorithms. 2. Apply search, satisfaction, optimization and learning algorithms to real world problems

Unit 1: Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format. **[16]**

Unit 2: 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. **[16]**

Unit 3: Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem. **[14]**

Unit 4: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. **[15]**

Unit 5: 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. **[12]**

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

Course code	Course title	L	T	P	Credits
BMA-332	**Mechanics**	4	1	-	5

Course Objectives:
1. Develop within the student an understanding of the scientific processes and theories designed to provide answers to the questioning mind. 2. Apply calculus techniques in solving problems.

Unit 1: Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two point equivalent loading, problems arising from structures, static indeterminacy. **[14]**

Unit 2: Laws of Coulomb friction, application to simple and complex surface contact friction problems,transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers. **[10]**

Unit3: Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes. **[10]**

Unit4: Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies. **[14]**

Unit 5: Chasles' theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references. **[12]**

TEXT BOOKS/REFERENCE BOOKS:

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics*, (4thEd.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics*, 11th Ed.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi .

Course outcomes:	
1.	Determine the resultant of a system of forces
2.	Students will learn Law of Coulomb

Lingaya's University

M.Sc. Mathematics Scheme (2018-19)

Semester-I				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1.	**MMA-110**	**Complex Analysis**	**4-1-0**	**5**
2.	**MMA-111**	**Functional Analysis**	**4-1-0**	**5**
3.	**MMA-112**	**Field Theory**	**4-1-0**	**5**
4.	**MMA-113**	**Differential Equations**	**4-1-0**	**5**
5.	**MMA-114**	**Numerical Analysis**	**4-1-0**	**5**
Total				**25**

Semester-II				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1.	**MMA-115**	**Topology**	**4-1-0**	**5**
2.	**MMA-116**	**Measure And Integration**	**4-1-0**	**5**
3.	**MMA-117**	**Module Theory**	**4-1-0**	**5**
4.	**MMA-118**	**Fluid Dynamics**	**4-1-0**	**5**
5.	**MMA-119**	**Probability & Statistics**	**4-1-0**	**5**
Total				**25**

Semester-III				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1.	**MMA-210**	**EL1(Any One)**	**4-1-0**	**5**
2.	**MMA-211**	**EL2(Any One)**	**4-1-0**	**5**
3.	**MMA-212**	**EL3(Any One)**	**4-1-0**	**5**
4.	**MMA-213**	**EL4(Any One)**	**4-1-0**	**5**
5.	**MMA-214**	**EL5(Any One)**	**4-1-0**	**5**
Total				**25**

Semester-IV				
S. No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1.	**MMA-215**	**EL6(Any One)**	**4-1-0**	**5**
2.	**MMA-216**	**EL7(Any One)**	**4-1-0**	**5**
3.	**MMA-217**	**EL8(Any One)**	**4-1-0**	**5**
4.	**MMA-218**	**EL9(Any One)**	**4-1-0**	**5**
5.	**MMA-219**	**EL10(Any One)**	**4-1-0**	**5**
Total				**25**

❖ **Courses offered in 2nd year (Semester-III)**

- **MMA-210: Elective 1 (Any One)**
  (i)Advanced Complex Analysis
  (ii) Representation of Finite groups

- **MMA-211: Elective 2 (Any One)**
  (i)Theory of Operators
  (ii)Integral Equations and Calculus Of Variations

- **MMA-212: Elective 3 (Any One)**
  (i)Advanced Group Theory
  (ii)Computational Fluid Dynamics

- **MMA-213: Elective 4 (Any One)**
  (i)Coding Theory
  (ii)Mathematical Programming

- **MMA-214: Elective 5 (Any One)**
  (i) Graph Theory
  (ii) Methods of Applied Mathematics

❖ Courses offered in 2nd year (Semester-IV)

- **MMA-215: Elective 6 (Any One)**
  (i)Differential Geometry
  (ii)Commutative Algebra

- **MMA-216: Elective 7 (Any One)**
  (i)Fourier Analysis
  (ii)Operators of Hardy-Hilbert Spaces

- **MMA-217: Elective 8 (Any One)**
  (i)Homology Theory
  (ii)Algebraic Number theory

- **MMA-218: Elective 9 (Any One)**
  (i)Advanced Coding Theory
  (ii)Optimization Techniques and Control Theory

- **MMA-219: Elective 10 (Any One)**
  (i)Calculus on R^n
  (ii) Measure Theory

Marking scheme:

Internal marks- 25 **External marks-75**

SYLLABUS

SEMESTER-I

CODE	NAME	CREDITS(5)
MMA-110	Complex Analysis	4-1-0

Unit-I: Analytic functions as mappings, conformal mappings, Mobius transformations, branch of logarithm, Riemann Stieltjes integrals.

Unit-II: Power series representation of analytic functions, maximum modulus theorem, index of a closed curve.

Unit-III: Cauchy's theorem and integral formula on open subsets of C. Homotopy.Homotopic version of Cauchy's theorem, simple connectedness, counting of zeros, open mapping theorem

Unit-IV: Goursat's theorem, Classification of singularities, Laurent series. Residue, Contour integration.

Unit-V: Argument principle, Rouche's theorem, Maximum principle, Schwarz' lemma.

Text book(s).

[1] J. B. Conway, Functions of One Complex Variable, Narosa, New Delhi, 2002. Reference books.
[1] L.V. Ahlfors, Complex Analysis, Mc. Graw Hill Co., New York, 1988.

[2] T. W. Gamelin, Complex Analysis, Springer Verlag, 2008.

[3] L. Hahn, B. Epstein, Classical Complex Analysis, Jones and Bartlett, India, New Delhi, 2011. [4] D. Ullrich, Complex Made Simple, Amer. Math. Soc., 2008.

CODE	NAME	CREDITS(5)
MMA-111	**Functional Analysis**	**4-1-0**

Unit-I: Normed spaces, Banach spaces, finite dimensional normed spaces and subspaces, compactness and finite dimension. Bounded and continuous linear 11 operators, linear operators and functionals on finite dimensional spaces. Normed spaces of operators, dual space.

Unit-II: Hilbert spaces, orthogonal complements and direct sums, Bessel inequality, total orthonormal sets and sequences.

Unit-III: Representation of functionals on Hilbert spaces. Hilbert adjoint operator. Self-adjoint, unitary and normal operator.

Unit-IV: Hahn Banach theorems for real / complex and normed spaces. Adjoint operator, reflexive spaces. Uniform boundedness theorem strong and weak convergence, convergence of sequences of operators and functionals.

Unit-V: Open mapping theorem, closed graph theorem Spectrum of an operator, spectral properties of bounded linear operators, non-emptiness of the spectrum.

Text book(s).

[1] E. Kreyszig, Introductory Functional Analysis with Applications.

Reference books.

[1] G. Bachman and L. Narici, Functional Analysis.

[2] R. Bhatia, Notes on Functional Analysis

[3] M. Schechter, Principles of Functional Analysis

CODE	NAME	CREDITS(5)
MMA-112	**Field Theory**	**4-1-0**

Unit-I: Fields and their extensions, splitting fields, the algebraic closure of a field.

Unit-II: Separability, automorphisms of field extensions

Unit-III: The fundamental theorem of Galois Theory, roots of unity

Unit-IV: Finite fields, primitive elements, Galois Theory of equations

Unit-V: The solution of equations by radicals.

Reference books.

[1] P.M. Cohn, Basic Algebra, Springer International Edition, 2003.

[2] P.M. Cohn, Classic Algebra, John Wiley & Sons Ltd., 2000.

[3] N. Jacobson, Basic Algebra I & II, Hindustan Publishing Co., 1989.

[4] T. W. Hungerford, Algebra, Springer-Verlag, 1981.

CODE	NAME	CREDITS(5)
MMA-113	**Differential Equations**	**4-1-0**

Unit-I: Well posed problems. Existence, uniqueness and continuity of the solution of ordinary differential equation of first order, Picard's method. Existence and uniqueness of the solution of simultaneous differential equations of first order and ordinary differential equation of higher order. Sturm separation and comparison theorems, Homogeneous linear systems, Non-homogeneous Linear systems, Linear systems with constant coefficients.

Unit-II: Two point boundary value problems, Greens function, Construction of Green functions, Sturm-Lioville systems, Eigen values and Eigen functions. Stability of autonomous system of differential equations, critical point of an autonomous system and their classification as stable, asymptotically 9 stable, strictly stable and unstable. Stability of linear systems with constant coefficients. Linear plane autonomous systems, Perturbed systems. Method of Lyapunov for nonlinear systems.

Unit-III: Fourier transform and its application to solution of PDEs, Boundary value problems, Maximum and minimum principles, Uniqueness and continuous dependence on boundary data, Solution of the Dirichlet and Neumann problem for a half plane by Fourier transform method. Solution of Dirichlet problem for a circle in form of Poission integral formula.

Unit-IV: Theory of Green function for Laplace equation in two dimension and its application in solution of Dirichlet and Neumann problem for half plane and circle, Theory of Green function for Laplace equation in three dimension and its application in solution of Dirichlet and Neumann Problem for semi-infinite space and sphere.

Unit-V: Wave equation, Helmholtz's first and second theorems, Green's function for wave equation. Duhamel's principles for wave equation, Diffusion equation, Solution of initial boundary value problems for the diffusion equation, Green's function for diffusion equation, Duhamel's principles for heat equation.

Text book(s).

[1] E.A. Coddington, An Introduction to Ordinary Differential Equations

[2] Tyn Myint-U, Ordinary Differential Equations

[3] Ian N. Sneddon, Elements of Partial Differential Equations

Reference books.

[1] G.F. Simmons, Ordinary Differential Equations with applications and Historical notes

[2] Tyn Myint-U Linear Partial Differential Equations for Scientists and Engineers.

[3] S.L.Ross, Differential Equation

CODE	NAME	CREDITS(5)
MMA-114	**Numerical Analysis**	**4-1-0**

Unit-I: Newton-Raphson method for Complex roots, Solution of system of nonlinear equations by Seidal Iteration method, Newton-Raphson method. Lagrange's form of interpolating polynomial, Existence and uniqueness of interpolating polynomial, Hermite, Piecewise and Cubic spline interpolation.

Unit-II: Approximation: Weighted least squares approximation, Method of least squares for continuous functions, Gram-Schmidt orthogonalization process, Approximation of functions using Chebyshev polynomials.

Unit-III: Numerical integration: Romberg's method, Guass Quadrature formula and error estimation.

Unit-IV: Numerical solution of Initial Value Problems: Runge-Kutta method of order four for system of equations, second and higher order differential equations, Boundary Value problems by Shooting method, Finite difference method, Convergence of finite difference scheme, Stability Analysis.

Unit-V: Numerical solution of partial differential equations: Parabolic equations- explicit methods and Crank-Nicolson method with stability analysis. Elliptic equations- Standard five point formula, Jacobi's iteration method and Leibmann's method, Hyperbolic equations: Explicit finite difference method.

Reference Books

1. Gerald & Wheatlay: Applied Numerical Analysis, Pearson.

2. M. K. Jain, S.R.K Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age Int., New Delhi.

3. G.D. Smith, Numerical Solutions of Partial Differential Equations, Clarendon Press Oxford.

4. S.D. Conte & Carl De Boor, Elementary Numerical Analysis, McGraw Hill, NY

5. Naseem Ahmad, Fundamentals Numerical Analysis with error estimation

SEMESTER-II

CODE	NAME	CREDITS(5)
MMA-115	**Topology**	**4-1-0**

Unit-I: Topological spaces, derived concepts: interior, closure, boundary and limit points of subsets, basis and subbasis for a topology

Unit-II: Order topology, subspaces, continuous functions, homeomorphism, product topology, metrisability of products of metric spaces

Unit-III: Connected spaces, components, path connected spaces, local connectedness, local path-connectedness

Unit-IV: Convergence: sequences and nets, Hausdorff spaces, 1st and 2nd countable spaces, separable and Lindel¨of spaces

Unit-V: Compactness, Tychonoff Theorem, BolzanoWeierstrass property, countable compactness.

Reference books.

[1] G. E. Bredon, Topology and Geometry.

[2] J. Dugundji, Topology.

[3] J.L. Kelley, General Topology.

[4] J. R. Munkres, Topology.

[5] T. B. Singh, Elements of Topology.

[6] S. Willard, General Topology.

CODE	NAME	CREDITS(5)
MMA-116	**Measure And Integration**	**4-1-0**

Unit-I: Lebesgue outer measure, measurable sets, regularity, measurable functions, Borel and Lebesgue measurability, non-measurable sets Integration of nonnegative functions

Unit-II: The general integral, integration of series, Riemann and Lebesgue integrals Functions of bounded variation

Unit-III: Lebesgue differentiation theorem, differentiation and integration, absolute continuity of functions

Unit-IV: Measures and outer measures, measure spaces, integration with respect to a measure The L p spaces

Unit-V: Holder and Minkowski inequalities, completeness of L p spaces, convergence in measure, almost uniform convergence, Egorov's theorem.

Text book(s).

[1] G. de Barra, Measure and Integration.

Reference books.

[1] M. Capinski and E. Kopp, Measure, Integral and Probability.

[2] E. Hewitt and K. Stromberg, Real and Abstract Analysis.

[3] H. L. Royden, Real Analysis.

CODE	NAME	CREDITS(5)
MMA-117	**Module Theory**	**4-1-0**

Unit-I: Modules, Basic Concepts, Direct product and Direct sums, Exact sequences, Split exact sequences

Unit-II: Nakayama lemma, Free modules, Modules over P.I.D.

Unit-III: Chain conditions, Hilbert basis theorem, Categories and Functors, Hom functors

Unit-IV: Tensor product of modules, Semi simple modules.

Unit-V: Projective and Injective modules, Baer's criterion, Divisible modules.

Reference books.

[1] P.M. Cohn, Classic Algebra, John Wiley & Sons Ltd., 2000.

[2] P.M. Cohn, Basic Algebra, Springer International Edition, 2003.

[3] D. S. Dummit & R.M. Foote, Abstract Algebra, Wiley India Pvt. Ltd.

[4] T.W. Hungerford, Algebra, Springer-Verlag, 1981

[5] N. Jacobson, Basic Algebra, Volume II, Hindustan Publishing Co., 1989.

CODE	NAME	CREDITS(5)
MMA-118	**Fluid Dynamics**	**4-1-0**

Unit-I: Classification of fluids, the continuum model, Eulerian and Lagrangian approach of description. Differentiation following fluid motion. Irrotational flow,vorticity vector, equi-potential surfaces. Streamlines, pathlines, streak lines of the particles, stream tube and stream surface.

Unit-II: Mass flux density, conservation of mass leading to equation of continuity. (Euler's form.) Conservation of momentum and its mathematical formulation:

Unit-III: Euler's form. Integration of Euler's equation under different conditions. Bernoulli's equation, steady motion under conservative body forces, Boundary surface, Theory of irrotational motion, Kelvin's minimum energy and circulation theorems, potential theorems. Some two-dimensional flows 12 of irrotational, incompressible fluids.

Unit-IV: Complex potential. Sources, sinks, doublets and vortices. Milne-Thomson circle theorem, Images with respect to a plane and circles. Blasius theorem. Three-dimensional flows. Sources, sinks, doublets. Axi-symmetric flow and Stokes stream function. Butler sphere theorem, Kelvin's inversion theorem and Weiss's sphere theorem. Images with respect to a plane and sphere.

Unit-V: Axi-symmetric flows and stream function. Motion of cylinders and spheres. Viscous flow, stress and strain analysis. Stokes hypothesis, The NavierStokes equations of motion. Some exactly solvable problems in viscous flows, steady flow between parallel plates, Poiseuille flow, steady flow between concentric rotating cylinders.

Text book(s).

[1] F.Chorlton : Text book of Fluid Dynamics , CBS 2004.

Reference books.

[1] P.K. Kundu and I.M. Cohen, Fluid Mechanics, Academic Press, 2005.

[2] L.M.MilneThomson, Theoretical Hydrodynamics, The Macmillan company, USA, 1969.

[3] N.E.Neill and F. Chorlton, Ideal and incompressible fluid dynamics, Ellis Horwood Ltd, 1986.

[4] N.E.Neill and F. Chorlton, Viscous and compressible fluid dynamics, Ellis Horwood Ltd, 1986.

[5] D.E.Rutherford: Fluid Dynamics, Oliver and Boyd Ltd, London, 1978.

CODE	NAME	CREDITS(5)
MMA-119	**Probability & Statistics**	**4-1-0**

Unit-I: Combinatorial probability, Independence of events, Conditional probabilities, Random variables, densities, Expectation, Variance and moments, Standard univariate distributions

Unit-II: Independence of random variables, T-chebychev's inequality and weak law of large numbers, Conditional expectation

Unit-III: Regression, Correlation, Multivariate normal distribution. Central Limit Theorem.

Unit-IV: Introduction to Statistics with examples of its use, Descriptive statistics, Distribution theory for transformations of random vectors, Sampling distributions based on normal populations - t, chi-square and F distributions

Unit-V: Bivariate normal distribution. Theory and Methods of Estimation, maximum likelyhood estimator. Hypothesis testing: one sample and two sample tests based on t, chi-square and F distributions.

Textbooks

1. R. Ash: *Basic Probability Theory*, : John Wiley & Sons (1970).

Reference Books:

1. P. Billingsley: *Probabilty and Measure, Third Edition*, John Wiley & Sons (1995).

2. W. Feller: *Introduction to Probability Theory and its Applications, Volume 1, Third Edition*, John Wiley & Sons (1972).
3. P.G. Hoel, S.C. Port & C.J. Stone: *Introduction to Probability Theory* Houghton-Miffin (1971) .
4. G.K. Bhattacharya & R.A. Johnson: *Statistics : Principles and Methods, Second Edition*, John Wiley & Sons (1992).
5. P.J. Bickel & K.A. Doksum: *Mathematical Statistics*, Holden-Day, (1977).
6. P. G. Hoel, S. C. Port, and C. J. Stone: *Introduction to Statistical Theory*, Houghton Mifflin (1971).

SEMESTER-III

CODE	NAME	CREDITS(5)
MMA-210(A)	**Advanced Complex Analysis**	**4-1-0**

Unit-I: Hadamard's three circles theorem, Phragmen-Lindelof theorem. The space of continuous functions C(G, Ω), spaces of analytic functions, Hurwitz's thorem, Montel's theorem, spaces of meromorphic functions.

Unit-II: Riemann mapping theorem, Weiersirass' factorization theorem, factorization of the sine function. Runge's theorem, simply connected regions, Mittag-Leffler's theorem

Unit-III: Harmonic functions, maximum and minimum principles, harmonic functions on a disk, Harnack's theorem

Unit-IV: Sub-harmonic and super-harmonic functions, maximum and minimum principles, Dirichlet problem, Green's function.

Unit-V: Entire functions. Jensen's formula, Bloch's theorem, Picard theorems, Schottky's theorem.

Text book(s).

[1] J. B. Conway, Functions of One Complex Variables, 2nd ed, Narosa Publishing House, New Delhi, 2002.

Reference books.

[1] L.V. Ahlfors, Complex Analysis, Mc. Graw Hill Co., New York, 1988.

[2] L. Hahn, B. Epstein, Classical Complex Analysis, Jones and Bartlett, India, New Delhi, 2011.

[3] W. Rudin, Real and Complex Analysis, McGraw-Hill, 1987

[4] D. Ullrich, Complex Made Simple, Amer. Math. Soc., 2008

CODE	NAME	CREDITS(5)
MMA-210(B)	**Representation of Finite groups**	**4-1-0**

Unit-I: Representation of groups, right regular representation, coset representation, matrix representation, linear representation, trivial representation, equivalent matrix representations,

Unit-II: G-modules, automorphism representations, characters, class function, reducibility, reducible and irreducible G-modules, contra gradient representation, permutation representations, complete irreducibility,

Unit-III: Maschke's theorem for matrix representations and G-modules, Schur's lemma for matrix representations and G-modules, commutant (endomorphism) algebra. Elementary property of group characters, orthogonality relations, inner product for functions on a group G, orthogonal functions, character relations of the first kind, simple and compound characters,

Unit-IV: Group algebra, character table, character relatioins of the second kind, character table for finite abelian groups, the lifting process, linear characters. Induced representations, induced characters, restricted character, reciprocity theorem of Frobenius, character tables for alternating groups of degree 4 and 5

Unit-V: Conjugate characters, Clifford's theorem, tensor products and Mackey's theorem, Algebraic numbers and conjugates, algebraic integers and their properties, representation of group algebras, Burnside's (p,q)- theorem, Frobenius groups.

Text book(s).

[1] James Gordan and Martin Lieback, Representations and characters of groups, Cambridge University Press, Cambridge, 2001.

Reference books.

[1] Charles W. Curtis and Irving Reiner, Representation Theory of finite groups and associative algebras, AMS Chelsea Publishing, American Mathematical Society reprint, 2006.

[2] William Fulton and Joe Harris, Representation Theory: A first course, Springer-Verlag, New York Inc., 1991.

[3] I. Martin Isaacs, Character Theory of finite groups, AMS Chelsea Publishing, American Mathematical Society reprint, 2006.

[4] Walter Ledermann, Introduction to group characters, Cambridge University Press, Cambridge, 1987.

[5] J. P. Serre, Linear representation of finite groups, Springer-Verlag, 1977.

CODE	**NAME**	**CREDITS(5)**
MMA-219(B)	**Measure Theory**	**4-1-0**

Unit-I: Signed measures, complex measures, Hahn decomposition theorem, Jordan decomposition theorem, mutually singular measures, Radon-Nikodym theorem, Lebesgue decomposition.

Unit-II: Caratheodory extension theorem, Lebesgue measure on R n , uniqueness up to multiplication by a scalar of Lebesgue measure in R n as a translation invariant Borel meaasure.

Unit-III: Riesz representation theorem for bounded linear functionals on L p -spaces, Product measures, Fubini's theorem, Tonelli's theorem.

Unit-IV: Baire sets, Baire measures, continuous functions with compact support, regularity of measures on locally compact spaces.

Unit-V: Regularity of Lebesgue measure in R n . Riesz Markov representation theorem.

Text book(s).

[1] H. L. Royden, Real Analysis, 3rd Edition, Prentice Hall, 1988

Reference books.

[1] C. D. Aliprantis and O. Burkinshaw, Principles of Real Analysis, Academic Press, Indian Reprint, 2011

[2] A. K. Berberian, Measure and Integration, AMS Reprint, 2011

[3] P. R. Halmos, Measure Theory, East-West Press Pvt. Ltd., 1978

[4] M. E. Taylor, Measure Theory, AMS, 2006

CODE	NAME	CREDITS(5)
MMA-211(A)	**Theory of Operators**	**4-1-0**

Unit-I: Spectrum of a bounded operator: Review of basic concepts, point, continuous and residue spectrum, and of notions of uniform, strong and weak operator convergence on the space of bounded linear operators.

Unit-II: Approximate point spectrum and compression spectrum, spectral mapping theorem for polynomials.

Unit-III: Compact linear operators: Basic properties, adjoint of compact operators, Spectral properties of compact operators, the Fredholm alternative.

Unit-IV: Spectral theory of self-adjoint operators : spectral properties of self adjoint operators, positive operators and their properties, spectral representation of a self adjoint compact operator, spectral family of a self adjoint operator and its properties

Unit-V: Spectral representation of a self adjoint operator, continuous functions of self-adjoint operators. Polar decomposition, singular values, trace class operators, trace norm and trace, Hilbert Schmidt operators.

Reference books.

[1] R. Bhatia, Notes on Functional Analysis, TRIM series, Hindustan Book Agency, India, 2009.

[2] J.E. Conway, A course in Operator Theory, Graduate Studies in Mathematics, Volume 21, AMS (1999)

[3] E. Kreyszig, Introductory Functional Analysis with Applications,John Wiley and Sons (2001)

[4] Martin Schechter, Principles of Functional Analysis, American Mathematical Society, (2004)

CODE	NAME	CREDITS(5)
MMA-211(B)	**Integral Equations and Calculus Of Variations**	**4-1-0**

Unit-I: Linear integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series in , Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind. 6

Unit-II: Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels, Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homogenous Fredholm equations with degenerate kernels.

Unit-III: Green's function, Use of method of variation of parameters to construct the Green's function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green's function

Unit-IV: Orthogonal series representation of Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green's function. Hilbert-Schmidt theory for symmetric kernels.

Unit-V: Motivating problems of calculus of variations, Shortest distance, Minimum surface of revolution, Branchistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints

Reference Books:

1. Jerri, A.J., Introduction to Integral Equations with Applications, A WileyInterscience Pub.

2. Kanwal, R.P., Linear Integral Equations, Theory and Techniques, Academic Press, New York.

3. Gelfand, J.M. and Fomin, S.V., Calculus of Variations, Prentice Hall, New Jersy, 1963.

4. Weinstock , Calculus of Variations, McGraw Hall.

5. Abdul-Majid wazwaz, A first course in Integral Equations, World Scientific Pub.

6. David, P. and David, S.G. Stirling, Integral Equations, Cambridge University Press. 7

CODE	**NAME**	**CREDITS(5)**
MMA-212(A)	**Advanced Group Theory**	**4-1-0**

Unit-I: Normal series, composition series Zessenhaus lemma, Schreier's refinement theorem, Jordan-Holder theorem. Solvable groups, derived series, supersolvable groups, minimal normal subgroup,

Unit-II: Hall's theorem, Hall subgroup, p-complements, central series, nilpotent groups, Schur's theorem

Unit-III: Fitting subgroup, Jacobi identity, Three subgroup lemma, Frattini subgroup, Burnside basis theorem. Fitting's lemma, Krull-Schmidt theorem,

Unit-IV: Extension of a group, semidirect products, Schur-Zassenhaus lemma, Burnside normal complement theorem and its consequences.

Unit-V: Free group, generators and relations, Fundamental groups of complexes, Tietze's theorem, Covering complexes, Coset enumeration. Free products, Kurosh theorem, free product with amalgamation.

Text book(s).

[1] J. J. Rotman. An introduction to the theory of groups, Springer-Verlag, New York, 1995.

Reference books.

[1] T. W. Hungerford, Algebra, Springer-Verlag, New York, 1981.

[2] D. J. S. Robinson, A course in the theory of groups, Springer-Verlag, New York, 1996.

[3] J. S. Rose, A course on group theory, Dover Publication, New york, 1994.

[4] M. Suzuki, Group theory-I, Springer-Verlag, Berlin, 1982.

CODE	NAME	CREDITS(5)
MMA-212(B)	**Computational Fluid Dynamics**	**4-1-0**

Unit-I: Mathematical description of the physical phenomena. Governing equationsmass, momentum, energy, species. General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations. Basics of discretization methods: explicit and implicit approaches.

Unit-II: Methods for deriving discretization equations by finite differences to one-dimensional and twodimensional parabolic, elliptic and hyperbolic equations. Schmidt, DufortFrankel, Lax-Wendroff, Crank-Nicolson and ADI methods.

Unit-III: Methods for solving discretized equations. Accuracy, stability and convergence of the finite difference methods. Methods for deriving discretization equations by finite volume methods.

Unit-IV: Convection and Diffusion- Steady onedimensional convection and diffusion, upwind, exponential, hybrid, power, QUICK schemes. Two-dimensional convection-diffusion, accuracy of upwind scheme; false diffusion and dispersion, boundary conditions.

Unit-V: Flow field calculation, pressurevelocity coupling, vorticity-stream function formulation, staggered grid, SIMPLE, SIMPLER and PISO algorithms. Finite volume methods for unsteady flows; One-dimensional unsteady heat conduction, implicit method for two-dimensional problem.

Text book(s).

[1] D.A. Anderson J.C. Tannehill and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor and Francis, Hemisphere Pub. Comp., USA, 1997.

Reference books.

[1] John D. Anderson, Computational Fluid Dynamics, McGraw-Hill, 1995.

[2] S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis, Hemisphere Pub. Comp., USA, 2004.

[3] H.K.Versteeg, and W.Malalasekera , An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson, 2007.

[4] T.J. Chung, Computational Fluid Dynamics, Cambridge Univ.Press, Newyork, USA, 2002.

CODE	NAME	CREDITS(5)
MMA-213(A)	**Coding Theory**	**4-1-0**

Unit-I: Tree codes, Convolutional codes, Description of linear tree and convolutional codes by matrices, Standard array, Bounds on minimum distance for convolutional codes, V-G-S bound, Bounds for burst-error detecting and correcting convolutional codes, The Lee metric, Packing bound for Hamming code w.r.t. Lee metric

Unit-II: The algebra of polynomials, Residue classes, Galois fields, Multiplicative group of a Galois field. Cyclic codes, Cyclic codes as ideals, Matrix description of cyclic codes, Hamming and Golay codes as cyclic codes, Error detection with cyclic codes

Unit-III: Error-correction procedure for short cyclic codes, Shortended cyclic codes, Pseudo cyclic codes. Code symmetry, Invariance of codes under transitive group of permutations

Unit-IV: Bose-Chaudhary-Hocquenghem (BCH) codes, BCH bounds, ReedSolomon (RS) codes, Majority-logic decodable codes, Majority-logic decoding.

Unit-V: Singleton bound, The Griesmer bound, Maximum-distance separable (MDS) codes, Generator and parity-check matrices of MDS codes, Weight distribution of MDS code, Necessary and sufficient conditions for a linear code to be an MDS code, MDS codes from RS codes, Abramson codes, Closed-loop burst-error correcting codes (Fire codes), Error locating codes.

Text book(s).

[1] F.J. Macwilliams and N.J. A. Sloane, Theory of Error Correcting Codes, North- Holland Publishing Company, 2006.

[2] W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes, M.I.T. Press, Cambridge, Massachusetts, 1972.

Reference books.

[1] E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1984.

[2] W.C. Huffman and V. Pless, The Theory of Error Correcting Codes, CambridgebUniversity Press, 1998.

CODE	NAME	CREDITS(5)
MMA-213(B)	**Mathematical Programming**	**4-1-0**

Unit-I: Existence theorems, First order optimality conditions and second order optimality conditions for unconstrained optimization problems

Unit-II: Ekeland's variational principle Convex functions, Differentiable convex functions, Optimization on convex sets, Separation theorems, Fritz John optimality conditions for constrained nonlinear programming problems,

Unit-III: Constraint qualifications Karush Kuhn Tucker conditions in nonlinear programming, Second order conditions in nonlinear programming Lagragian saddle points

Unit-IV: Duality in nonlinear programming, Strong duality in convex programming, duality for linear and quadratic problems.

Unit-V: Quadratic programming, Wolfe's method as application of Karush Kuhn Tucker conditions, convex simplex method, Penalty function methods.

Text book(s).

[1] Mokhtar S. Bazaraa, Hanif D. Sherali and C.M. Shetty, Nonlinear Programming: Theory and Algorithms, John Wiley & Sons, 2006.

[2] Osman Gler, Foundations of Optimization, Springer 2010.

[3] David G. Luenberger and Yinyu Ye, Linear and Nonlinear Programming, Springer, 2008.

Reference books.

[1] Jan Brinkhuis and Vladimir Tikhomirov, Optimization : Insights and Applications, Princeton University Press, 2005.

[2] Kenneth Lange, Optimization, Springer 2013.

CODE	NAME	CREDITS(5)
MMA-214(A)	**Graph Theory**	**4-1-0**

Unit-I: Graphs: Vertices of graphs, Walks and connectedness, Degrees, Operations on graphs

Unit-II: Blocks, Cut-points, bridges and blocks, Block graphs and cutpoint graphs

Unit-III: Trees: Elementary properties of trees, Centers and Centroids, Block-cut point trees, Independent cycles and cocycles

Unit-IV: Connectivity and Traversability: Connectivity and line connectivity, Menger's theorems, Eulerian graph, Hamiltonian graphs

Unit-V: Planarity and Coloring: Planar graphs, outer planar graphs, Kuratowski's theorem, dual graphs, chromatic number, five color theorem.

Text book(s).

[1] F. Harary, Graph theory, Narosa Publishing House, New Delhi, 1988.

Reference books.

[1] R. Balakrishnan and K. Renganathan, A textbook of Graph theory, Springer, 2000

[2] Bela Bollobas, Modern Graph Theory Springer, 2002

[3] G. Chartrand, L. Lesniak, Graphs & digraphs. Fourth edition. Chapman & Hall/CRC, 2005.

[4] Robin J. Wilson, Introduction to Graph Theory (4th Edition), Addison Wesley, 1996

CODE	NAME	CREDITS(5)
MMA-214(B)	**Methods of Applied Mathematics**	**4-1-0**

Unit-I: Dimensional analysis, Buckingham Pi Theorem, Scaling, Perturbation methods, regular perturbations, singular perturbations, WKB approximations

Unit-II: Integral equation: introduction and relation with linear differential equation. Volterra integral equations and its solutions: Method of resolvent kernel, Method of successive approximations.

Unit-III: Convolution type of equation: Method of Laplace Transform, System of volterra integral equations, Integro-differential equation. Abel's integral equation and its generalizations.

Unit-IV: Fredholm integral equations and its solutions: Method of resolvent kernels, Method of successive approximations. Integral equations with degenerate kernels, Eigen values and eigen functions and their properties, Hilbert Schmidt theorem, Non homogeneous Fredholm integral equation with symmetric kernel, Fredholm alternative.

Unit-V: Variational problems. the variation of a functional and its properties, Extremum of functional, Necessary condition for an extremum, Euler's equation and its generalization, the variational derivative, General variation of a functional and variable end point problem, sufficient conditions for the extremum of a functional.

Text book(s).

[1] M.L. Krasnov, Problems and exercises integral equations, Mir Publication Moscow, 1971

[2] M. Gelfand and S.V. Fomin, Calculus of variations, Prentice Hall, Inc., 2000. 23

[3] D. Logan: Applied mathematics: A contemporary approach, John Wiley and Sons, New York, 1997.

Reference books.

[1] F.B. Hildebrand, Methods of applied mathematics, Dover Publication, 1992.

SEMESTER-IV

CODE	NAME	CREDITS(5)
MMA-215(A)	**Differential Geometry**	**4-1-0**

Unit-I: Graph and level sets, vector fields, the tangent space.

Unit-II: Surfaces, orientation, the Gauss map, geodesics, parallel transport

Unit-III: The Weingarten map, curvature of plane curves, arc length and line integrals

Unit-IV: Curvature of surfaces, parametrized surfaces

Unit-V: Surface area and volume, surfaces with boundary, the Gauss-Bonnet Theorem.

Reference books.

[1] Wolfgang Kuhnel: Differential Geometry - curves-surfaces- Manifolds. Second Edition, 2006, AMS.

[2] A: Mishchenko and A. Formentko. A course of Differential Geometry and topology) Mir Publishers Moscow, 1988.

[3] Andrew Pressley: Elementary Differential Geometry. SUMS (Springer), 2001 (Ist Indian Repring 2004).

[4] I.A. Thorpe: Elementary Topics in Differential Geometry. Springer, 1979 (Ist Indian Reprint 2004).

CODE	NAME	CREDITS(5)
MMA-215(B)	Commutative Algebra	4-1-0

Unit-I: Extension and Contraction of ideals, Prime spectrum of Rings, Jacobson radical of a ring, Prime avoidance lemma, Rings of formal power series.

Unit-II: Restriction and extension of scalars Localisation, Local properties, Extended & contracted ideals in rings of fractions,

Unit-III: Primary decomposition, First and second uniqueness theorem of primary decomposition, Noetherian rings, Primary decomposition in Noetherian rings

Unit-IV: Artin rings, Structure theorem for Artin rings, Integral dependence, Going up theorem, Going down theorem.

Unit-V: Integrally closed domains, Valuation rings, Hilbert's Nullstellensatz theorem, Discrete valuation rings, Dedekind domains, Fractional ideals.

Text book(s).

[1] M.F. Athiyah & I.G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969.

Reference books.

[1] Balwant Singh, Basic Commutative Algebra, World Scientific Publishing Co., 2011.

[2] D. Eisenbud, Commutative Algebra with a view towards algebraic geometry, Springer Verlag, 1995.

[3] O. Zariski & P. Samuel, Commutative Algebra, Vol. 1 & 2, SpringerVerlag, 1975.

[4] R.Y. Sharp, Steps in Commutative Algebra, Cambridge University Press, 1990

CODE	NAME	CREDITS(5)
MMA-216(A)	**Fourier Analysis**	**4-1-0**

Unit-I: Convergence and divergence of Fourier series, Fejer's theorem, approximate indentities, the classical kernels [Fejer's, Poisson's and Dirichlet's summability in norm and pointwise summability],

Unit-II: Fatou's theorem. The inequalities of Hausdorff and Young, examples of conjugate function series,

Unit-III: The Fourier tranform, kernels on R. Basic properties of topological groups, separation properties, subgroups, quotient groups and connected groups,

Unit-IV: Notion of Haar measure on topological groups with emphasis on R,T and Z and some simple matrix groups, L 1 (G) and convolution with special emphasis on L 1 (R), L 1 (T) and L 1 (Z).

Unit-V: Plancherel theorem on abelian groups, Plancherel measure on R,T and Z, maximal ideal space of L 1 (G) (G an abelian topological group).

Text book(s).

[1] Y. Katznelson, Introduction to Harmonic Analysis, John Wiley, 2004.

Reference books.

[1] H. Helson, Harmonic Analysis, Addison-Wesley, 983, Hindustan Pub. Co., 1994.

[2] E. Hewitt and K.A. Ross, Abstract Harmonic Analysis, Vol I, SpringerVerlag, 1993

CODE	NAME	CREDITS(5)
MMA-216(B)	**Operators of Hardy-Hilbert Spaces**	**4-1-0**

Unit-I: The Hardy Hilbert Space: Basic Definitions and properties. The unilateral shift and factorisation of Spectral structure.

Unit-II: functions: Shift operators, Invariant and reducing subspaces. Inner and outer factorisation, Blaschke factors, singular inner functions, outer functions.

Unit-III: Toeplitz operators: Basic properties of Toeplitz operators,spectral structure.

Unit-IV: Hankel operators: Bounded Hankel operators, Hankel operators of finite rank, Compact Hankel operators, self adjointness and normality of Hankel operators.

Unit-V: Relation between Hankel and Toeplitz operators.

Text book(s).

[1] R.A. Martinez-Avedano and P. Rosenthal, An Introdution to the Hardy Hilbert Space, Graduate Texts in Mathematics 237, Springer, 2007.

Reference books.

[1] R.G. Douglas, Banach Algebra Techniques in Operator Theory, Graduate Texts in Mathematics 179, Springer, 1998

[2] N.K. Nikolskii, Operators, Functions and Systems: An Easy Reading, Volume 1, Mathematical Surveys and Monographs 92, American Mathematical Society, 2002.

CODE	NAME	CREDITS(5)
MMA-217(A)	**Homology Theory**	**4-1-0**

Unit-I: Geometric simplexes, geometric complexes and polyhedra. Simplicial maps, barycentric subdivision, simplicial approximation of continuous maps, contiguous maps.

Unit-II: Orientation of geometric complexes, homology groups. Computation of homology groups, the homology of n-sphere.

Unit-III: The structure of homology groups, the chain complexes, chain mappings, chain derivation, chain homotopy. The homomorphism induced by continuous maps between two polyhedra.

Unit-IV: Functorial property of induced homomorphisms, Topological invariance of homology groupsThe degree of self mappings of S n . The Brower's fixed point theorem, Brower's degree Theorem

Unit-V: Euler-Poincare theorem, Euler's formula, Lefschetz fixed point theorem. Existence of eigen value, Relative homology groups. Invariance of dimension.

Reference books.

[1] H Agoston, Algebraic Topology, Marcel Dekker, 1976.

[2] M A Armstrong,Basic Topology, Springer-Verlag, 1983.

[3] F H Croom,Basic concepts of Algebraic Topology,1976.

[4] S. Deo, Algebraic Topology, A primer, Hindustan Book Agency (2006).

CODE	NAME	CREDITS(5)
MMA-217(B)	**Algebraic Number theory**	**4-1-0**

Unit-I: Algebraic Numbers, Conjugates and Discriminants, Algebraic Integers, Integral Bases, Norms and Traces, Rings of Integers, Quadratic Fields, Cyclotomic Fields.

Unit-II: Trivial Factorizations, Factorization into Irreducibles, Examples of NonUnique Factorization into Irreducibles, Prime Factorization

Unit-III: Euclidean Domains, Euclidean Quadratic Fields, Consequences of Unique Factorization, The Ramanujan-Nagell Theorem, Prime Factorization of Ideals. The Norm of an Ideal

Unit-IV: Nonunique Factorization in Cyclotomic Fields, Lattices, The Quotient Torus, Minkowski's Theorem, The Two-Squares Theorem, The-Four Squares Theorem, The Space Lst The Class-Group, An Existence Theorem

Unit-V: Finiteness of the Class-group, How to Make an Ideal Principal, Unique Factorization of Elements in an Extension Ring, Factorization of a Rational Prime, Minkowski's Constants, Some Class-Number Calculations.

Text book(s).

[1] I. N. Stewart and D. O. Tall, Algebraic Number Theory, Chapman and Hall, London, 1987.

Reference books.

[1] K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer-Verlag, 1990.

[2] S. Lang, Algebraic Number Theory, Springer-Verlag, New York Inc., 1994.

[3] D. A. Marcus, Number Fields, Springer-Verlag, New York Inc., 1987.

CODE	NAME	CREDITS(5)
MMA-218(A)	**Advanced Coding Theory**	**4-1-0**

Unit-I: Tree codes, Convolutional codes, Description of linear tree and convolutional codes by matrices, Standard array, Bounds on minimum distance for convolutional codes, V-G-S bound, Bounds for burst-error detecting and correcting convolutional codes

Unit-II: The Lee metric, Packing bound for Hamming code w.r.t. Lee metric, The algebra of polynomials, Residue classes, Galois fields, Multiplicative group of a Galois field.

Unit-III: Cyclic codes, Cyclic codes as ideals, Matrix description of cyclic codes, Hamming and Golay codes as cyclic codes, Error detection with cyclic codes, Error-correction procedure for short cyclic codes, Shortended cyclic codes, Pseudo cyclic codes.

Unit-IV: Code symmetry, Invariance of codes under transitive group of permutations, Bose-Chaudhary-Hocquenghem (BCH) codes, BCH bounds, ReedSolomon (RS) codes, Majority-logic decodable codes, Majority-logic decoding. Singleton bound, The Griesmer bound

Unit-V: Maximum-distance separable (MDS) codes, Generator and parity-check matrices of MDS codes, Weight distribution of MDS code, Necessary and sufficient conditions for a linear code to be an MDS code, MDS codes from RS codes, Abramson codes, Closed-loop burst-error correcting codes (Fire codes), Error locating codes.

Text book(s).

[1] F.J. Macwilliams and N.J. A. Sloane, Theory of Error Correcting Codes, North- Holland Publishing Company, 2006.

[2] W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes, M.I.T. Press, Cambridge, Massachusetts, 1972.

Reference books.

[1] E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1984.

[2] W.C. Huffman and V. Pless, The Theory of Error Correcting Codes, CambridgebUniversity Press, 1998.

CODE	NAME	CREDITS(5)
MMA-218(B)	**Optimization Techniques and Control Theory**	**4-1-0**

Unit-I: Extended real valued functions, Proper convex functions, Subgradients, Directional derivatives.

Unit-II: Conjugate functions, Dual convex programs, Optimality conditions and Lagrange multipliers, Duality and optimality for standard convex programs.

Unit-III: Gradient descent method, Gradient projection method. Newton's method, Conjugate gradient method, Dynamic programming, Bellman's principle of optimality.

Unit-IV: Allocation problem, Stage coach problem. 36 Optimal control problem and formulations, Variational approach to the fixed-time free endpoint problem.

Unit-V: Pontryagin's maximum principle, Dynamic programming and Hamilton-Jacobi-Bellman equation.

Reference books.

[1] Mordecai Avriel, Nonlinear Programming: Analysis & Methods, Dover Publications, New York, 2003.

[2] Osman Gler, Foundations of Optimization, Springer 2010.

[3] Frederick S. Hillier and Gerald J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2010.

[4] Daniel Liberzon, Calculus of Variations and Optimal Control Theory: A Concise Introduction, Princeton University Press, 2012.

[5] Jan Brinkhuis and Vladimir Tikhomirov, Optimization : Insights and Applications, Princeton University Press, 2005.

[6] Kenneth Lange, Optimization, Springer 2013.

CODE	NAME	CREDITS(5)
MMA-219(A)	**Calculus on R^n**	**4-1-0**

Unit-I: The differentiability of functions from R n to R m, partial derivatives and differentiability, directional derivatives and differentiability, chain rule, mean value theorems, inverse function theorem and implicit function theorem.

Unit-II: Derivatives of higher order, Taylor's formulas with integral reminder, Lagrange's reminder and Peano's reminder

Unit-III: Integration over a k-cell, primitive mappings, partition of unity, change of variables.

Unit-IV: Introduction to differential forms on R n , basic properties of differential forms, differentiation of differential forms, change of variables in differential forms.

Unit-V: Simplexes and chains, integration of differential forms, Stokes' theorem.

Text book(s).

[1] J.R. Munkres, Analysis on Manifolds, Addison Wesley, 1997

[2] W. Rudin, Principles of Mathematical Analysis, 3rd Edition, Mc Graw Hill, 1986

Reference books.

[1] M. Giaquinta and G. Modica, Mathematical Analysis, An introduction to functions of several variables, Birkhauser, 2009

[2] M. Spivak, Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus, Westview Press, 1998.

CODE	NAME	CREDITS(5)
MMA-219(B)	**Measure Theory**	**4-1-0**

Unit-I: Signed measures, complex measures, Hahn decomposition theorem, Jordan decomposition theorem, mutually singular measures, Radon-Nikodym theorem, Lebesgue decomposition.

Unit-II: Caratheodory extension theorem, Lebesgue measure on R n , uniqueness up to multiplication by a scalar of Lebesgue measure in R n as a translation invariant Borel meaasure.

Unit-III: Riesz representation theorem for bounded linear functionals on L p -spaces, Product measures, Fubini's theorem, Tonelli's theorem.

Unit-IV: Baire sets, Baire measures, continuous functions with compact support, regularity of measures on locally compact spaces.

Unit-V: Regularity of Lebesgue measure in R n . Riesz Markov representation theorem.

Text book(s).

[1] H. L. Royden, Real Analysis, 3rd Edition, Prentice Hall, 1988

Reference books.

[1] C. D. Aliprantis and O. Burkinshaw, Principles of Real Analysis, Academic Press, Indian Reprint, 2011

[2] A. K. Berberian, Measure and Integration, AMS Reprint, 2011

[3] P. R. Halmos, Measure Theory, East-West Press Pvt. Ltd., 1978

[4] M. E. Taylor, Measure Theory, AMS, 2006