Curriculum for

BA/B. Sc. in Mathematics (Hons.)

Learning Outcomes based Curriculum Framework (LOCF)
2021

Rajiv Gandhi University
(A Central University)
RONO HILLS, DOIMUKH,
ARUNACHAL PRADESH

05/7/2021
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
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PROGRAMME OBJECTIVES AND PROGRAMME LEARNING OUTCOMES

Programme Objectives

The main objectives of the B.Sc. (Hons.) Mathematics Programme are to:

(i) Inculcate strong interest in learning mathematics.

(ii) Evolve broad and balanced knowledge and understanding of definitions, key concepts, principles and theorems in Mathematics

(iii) Enable learners/students to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics.

(iv) Develop in students the ability to apply relevant tools developed in mathematical theory to handle issues and problems in social and natural sciences.

(v) Provide students with sufficient knowledge and skills that enable them to undertake further studies in mathematics and related disciplines

Programme Learning Outcomes

After completing the programme the students will be able to:

(i) Understand basic concepts of pure and applied mathematics.

(ii) Apply Mathematics as a tool to solve problems of other disciplines.

(iii) Pursue higher studies in the subject to take part in the academic upliftment of the subject.

(iv) Develop new techniques/methods for solving the unsolved problems mathematics and related disciplines.

Assessment Methods, Conduct of Examinations, Eligibility Conditions, and Declaration of results

Academic performance in various courses i.e. core, discipline electives, generic electives and skill enhancement courses are to be considered as parameters for assessing the achievement of students. All students shall be subjected to the process of continuous evaluation and assessment. A number of appropriate assessment methods will be used to determine the extent to which students demonstrate desired learning outcomes.

Marks allocation for Internal Assessment and End Semester Examinations, Question paper pattern, Duration of examination for various courses, Attendance and other eligibility conditions for appearing in the examination, and Declaration of results shall be done in accordance with the relevant provisions as stipulated in the regulation and also the Ordinance(s) of the University.

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CURRICULUM STRUCTURE IN B.SC. MATHEMATICS (HONS.)

Semester	Core Course (CC) (14 Papers) Credit: 6 each	Ability Enhancement Compulsory Course (AECC) (2 Papers) Credit: 4 each	Skill Enhancement Course (SEC) (4 Papers) Credit: 2 each	Discipline Specific Elective (DSE) (4 Papers) Credit: 6 each	Elective Generic (GE) (4 Papers) Credit: 6 each	Semester Wise Total Credit
I	MAT-CC-111 MAT-CC-112	AECC-1	SEC-1		GE-1	24
II	MAT-CC-121 MAT-CC-122	AECC-2	SEC-2		GE-2	24
III	MAT-CC-231 MAT-CC-232 MAT-CC-233		SEC-3		GE-3	26
IV	MAT-CC-241 MAT-CC-242 MAT-CC-243		SEC-4		GE-4	26
V	MAT-CC-351 MAT-CC-352			DSE-1 DSE-2		24
VI	MAT-CC-361 MAT-CC-362			DSE-3 DSE-4/ Dissertation		24
Total Credits	84	8	8	24	24	148

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DETAILS OF COURSES OF B.A./B.SC. IN MATHEMATICS (HONS.)

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
I	MAT-CC-111	Calculus	5	1	0	6
	MAT-CC-112	Higher Algebra	5	1	0	6
	XXX-AE-111	Ability Enhancement Compulsory Course(AECC) -1 (ENG-AE-111 OR HIN-AE-111)	4	0	0	4
	XXX-SE-xxx	Skill Enhancement Course (SEC)-1	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-1)	-	-	-	6
II	MAT-CC-121	Real Analysis	5	1	0	6
	MAT-CC-122	Analytic Geometry	5	1	0	6
	EVS-AE-121	Ability Enhancement Compulsory Course (AECC)-2	4	0	0	4
	XXX-SE-xxx	Skill Enhancement Course (SEC)-2	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-2)	-	-	-	6
III	MAT-CC-231	Abstract Algebra	5	1	0	6
	MAT-CC-232	Differential Equations	5	1	0	6
	MAT-CC-233	Statistics	5	1	0	6
	XXX-SE-xxx	Skill Enhancement Course (SEC-3)	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-3)	-	-	-	6
IV	MAT-CC-241	Particle Dynamics	5	1	0	6
	MAT-CC-242	Finite Differences and Numerical Analysis	5	1	0	6
	MAT-CC-243	Complex Analysis	5	1	0	6
	XXX-SE-xxx	Skill Enhancement Course (SEC-4)	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-4)	-	-	-	6
V	MAT-CC-351	Metric Space	5	1	0	6
	MAT-CC-352	Linear Algebra	5	1	0	6
	MAT-DE-35X	Discipline Specific Elective (DSE-1)	5	1	0	6
	MAT-DE-35Y	Discipline Specific Elective (DSE-2)	5	1	0	6
VI	MAT-CC-361	Advanced Calculus	5	1	0	6
	MAT-CC-362	Number Theory	5	1	0	6
	MAT-DE-36X	Discipline Specific Elective (DSE-3)	5	1	0	6
	MAT-DE-36Y	Discipline Specific Elective (DSE-4)	5	1	0	6

ABILITY ENHANCEMENT COMPULSORY COURSES (AECC)

Semesters	Course Code	Course Name	Credits			
			L	T	P	Total
I (Any One)	ENG-AE-111	Communicative English	3	1	0	4
	HIN-AE-111	हिंदी शिक्षण (Hindhi Sikshan)	3	1	0	4
II	EVS-AE-121	Environmental Studies	4	0	0	6

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DISCIPILINE SPECIFIC ELECTIVES (DSE)

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
V (DSE-1 & DSE-2)	MAT-DE-351	Discrete Mathematics	5	1	0	6
	MAT-DE-352	Dynamical Systems	5	1	0	6
	MAT-DE-353	Differential Geometry	5	1	0	6
	MAT-DE-354	Hydrostatics	5	1	0	6
	MAT-DE-355	Spherical Trigonometry	5	1	0	6
	MAT-DE-356	Linear Programming	5	1	0	6
	MAT-DE-357	Hydrodynamics	5	1	0	6
VI (DSE-3 & DSE-4)	MAT-DE-361	Spherical Astronomy	5	1	0	6
	MAT-DE-362	Probability and Statistics	5	1	0	6
	MAT-DE-363	Financial Mathematics	5	1	0	6
	MAT-DE-364	Computational Group Theory	5	1	0	6
	MAT-DE-365	Integral Transform and Vector Calculus	5	1	0	6
	MAT-DE-366	Fuzzy Sets and Fuzzy Logic	5	1	0	6
	MAT-DE-367	Dissertation/ Project	5	1	0	6

SKILL ENHANCEMENT COURSES (SEC)

Semesters	Course Code	Course Name	Credits			
			L	T	P	Total
I & III	MAT-SE-001	Fundamentals of Computers	2	0	0	2
	MAT-SE-003	Logic and Sets	2	0	0	2
	MAT-SE-005	Introduction to MATLAB	1	0	1	2
	MAT-SE-007	Introduction to MATHEMATICA	1	0	1	2
II & IV	MAT-SE-002	R Programming	1	0	1	2
	MAT-SE-004	Programming in C	1	0	1	2
	MAT-SE-006	LaTeX	1	0	1	2
	MAT-SE-008	Numerical Interpolation and Curve Fitting	2	0	0	2

GENERIC ELECTIVES (GE)

Semesters	Course Code	Course Name	Credits			
			L	T	P	Total
I & III	MAT-GE-001	Differential and Integral calculus	5	1	0	6
	MAT-GE-003	Discrete Mathematics	5	1	0	6
	MAT-GE-005	Basic Statistics and Probability	5	1	0	6
	MAT-GE-007	Coordinate Geometry	5	1	0	6
II & IV	MAT-GE-002	Elementary Algebra	5	1	0	6
	MAT-GE-004	Differential equation	5	1	0	6
	MAT-GE-006	Modern Algebra	5	1	0	6
	MAT-GE-008	Numerical Methods	5	1	0	6

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Core Courses (CC)

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MAT-CC-111
Calculus
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of this course is to introduce the graphs of functions and basic tools of calculus and their geometrical properties which are helpful in understanding their applications in real world problems.

Course Learning Outcomes: This course will enable the students to:
(i) Learn differentiability, limit and continuity tests for functions.
(ii) Learn different theorems along with their geometric properties.
(iii) Learn partial differentiation of functions

Unit-I: Functions, limit and continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Recursion formulae for higher order derivatives.
(Lectures: 25)

Unit-II: Tangents and normals, Curvature, Asymptotes, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar form.
(Lectures: 20)

Unit-III: Rolle's theorem, Mean Value theorems, Taylor's theorem and remainders, Taylor's series, Maclaurin's series. **(Lectures: 20)**

Unit-IV: Integration by successive reduction and applications, rectification of plane curves (Cartesian, parametric and polar curves), area under plane curves, volume and surface areas of solid of revolution.
(Lectures: 25)

Recommended Books:

1. T. G.B. Thomas and R.L. Finney, *Calculus,* 13th ed.. Pearson Education, Delhi. (2017).

2. S. Narayan & P. K. Mittal, *Differential Calculus*, S. Chand & Co Ltd; 15th ed. (1942).

3. S. Narayan & P. K. Mittal, *Integral Calculus*, S. Chand & Co Ltd; 35th ed. (2005)

4. B. C. Das & B. N. Mukherjee, *Differential Calculus*. U.N. Dhur & Sons Pvt. Ltd.; 57th ed (2019)

5. H. Anton, I. Bivens, & S. Davis, Stephen . *Calculus* (10th ed.). Wiley India Pvt. Ltd. Delhi (2013).

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MAT-CC-112
Higher Algebra
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, matrices and determinant to understand their applications.

Course Learning Outcomes: This course will enable the students to:
i) Employ De Moivre's theorem in a number of applications.
ii) Recognize consistent and inconsistent systems of linear equations by the row echelon form.
v) Learn about the solution sets of linear systems using matrix method .

Unit-I: Polar representation of complex numbers, n^{th} roots of Unity, De Moivre's theorem for rational indices and its applications, Expansions of $\sin n\theta$, $\cos n\theta$ and $\tan n\theta$, Evaluation of indeterminate quantities, Expansions of $\sin^n\theta$ and $\cos^n\theta$ in cosines or sines of multiples of θ, Expansions of $\sin n\theta$ and $\cos n\theta$ in series of descending and ascending powers of $\sin\theta$ and $\cos\theta$. **(Lectures: 30)**

Unit-II: Euler's expansion of cosine and sine, Hyperbolic functions and its applications; Inverse functions; Logarithmic functions of complex numbers; Gregory's series and its applications.
(Lectures: 15)

Unit-III: Polynomials and division algorithm; Roots of polynomial equations, Relations between the roots and the coefficients, Transformation of equations; Descartes rule of signs; Solution of cubic and biquadratic equations **(Lectures: 15)**

Unit-IV: Determinants & Matrices; Minors and cofactors, adjoint and inverse of a matrix. Systems of linear equations, row reduction and Normal forms, echelon forms, elementary operations on matrices, consistency of systems of linear system equations $Ax=b$, Gauss elimination method. Symmetric and skew-symmetric matrices, Hermitian and Skew-Hermitian matrices, Orthogonal matrices. Elementary operations on matrices. Rank of a matrix. **(Lectures: 30)**

Recommended Books:

1. J. Hall & P. Knight, *Higher Algebra* Arihant Publications; Sixth edition (2016)

2. S. Barnard & J M. Child, *Higher Algebra*, New Age International Private Limited (2017)

2. B.C. Das & M. Mukherjee, *Higher Trigonometry*, U.N. Dhur & Sons (P) Ltd. (2017)

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MAT-CC-121
Real Analysis
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course will develop a deep and rigorous understanding of real line R and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers.

Course Learning Outcomes: This course will enable the students to:
i) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit, algebra of limit and uniform continuity of functions.
ii) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit-I: Algebra of Real numbers, Order, Upper and Lower bounds, Least upper bound (LUB) and Greatest lower bound (GLB), Order-completeness, Cardinality of sets, countability, Higher order cardinals and cardinality of power sets. Intervals, closure, limit and interior points. Open sets, closed sets, Closure, interior and boundary of sets. Dense set, Compactness, Bolzano-Weierstrass theorem, Cantor's theorem, Heine-Borel theorem. **(Lectures: 25)**

Unit-II: Riemann integration-Definitions, geometrical interpretation and examples. Darboux's theorem. Existence of Riemann integral and conditions for integrability, integral as a limit of a sum. Mean value theorem. Fundamental theorem of calculus. **(Lectures: 25)**

Unit-III: Sequences, Cauchy's and Convergent sequences, convergence of sequences, Cauchy's general principle of convergence , Subsequence and Bolzano-Weierstrass theorem for sequences, monotonic sequence, Weierstrass completeness principle, , Limit superior and Limit inferior.

(Lectures: 20)

Unit-IV: Infinite series, Convergence series, Series of positive terms, Tests for convergence of series (comparison test, condensation test, Cauchy's root test, D'Alembert's ratio test), Absolute convergence, Rearrangement of terms of a series, conditionally convergent series, Power series. **(Lectures: 20)**

Books Recommended:

1. H. L. Royden & P. M. Fitzpatrick, *Real Analysis*, Pearson Education India; 4th edition (2015)

2. S. C. Mallik and S. Arora, *Mathematical Analysis*, New Age Int. Pub. (2017).

3. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis* Wiley (Asia) P.Ltd., (2011).

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MAT-CC-122
Analytic Geometry
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of this course is to introduce the basic tools of two dimensional coordinate systems, general conics, and three dimensional coordinates systems. Also, introduces the vectors in coordinate systems with geometrical properties

Course Learning Outcomes: This course will enable the students to:
i) Transform coordinate systems, conic sections
ii) Learn polar equation of conic, tangent, normal and related properties
iii) Have a rigorous understanding of the concept of three dimensional coordinate systems

Unit-I: Change of Axes: Transformation of coordinates, Translation of axes, Rotation of axes, Removal of xy-terms and the first degree terms, Invariants. Pair of Straight lines: Homogeneous equations of second degree, Angle between a pair of lines, Bisectors of the angles between the pair of lines, Condition for the general equation of second degree to represent a pair of lines, pairs of parallel and perpendicular lines, points of intersection of a line and curve. **(Lectures: 30)**

Unit-II: Conic section; Parabola, hyperbola, and ellipse. general conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal and properties. **(Lectures: 20)**

Unit-III: Introduction to three dimensional geometry: Different forms of straight lines and planes, Skew lines, Coplanar lines, Angle between two planes, Shortest distance between two lines and equations of shortest distance. Sphere: Plane section of a sphere, intersection of two spheres, sphere with a given diameter, Equation of a sphere through a given circle. **(Lectures: 25)**

Unit-IV: Cones and Cylinders: Definition, Equation of a cone with a conic as guiding curve, the right circular cone, its definition and equation. Definition and equation of cylinder and right circular cylinder. **(Lectures: 15)**

Recommended Books:

1. R. M. Khan, *Analytical Geometry of Two and Three dimension and vector analysis*. New Central Book Agency (2012).
2. P. R. Vittal, *Analytic Geometry: 2D and 3D*, Pearson Education India; First edition (2013)
3. R. J. T. Bell, *Coordinate Solid Geometry*, Macmillan, 1983.

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MAT-CC-231
Abstract Algebra
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course will develop a understanding of different types of abstract algebraic structures and its properties.

Course Learning Outcomes: This course will enable the students to:
(i) Recognize fundamental algebraic structures like group, rings, integral domain, and field.
(ii) It will enable students to learn how to prove theorems in abstract setting.

Unit-I: Relations and functions, permutations, Binary operations, groups and subgroups, Caley's table, order of groups and elements. Finite groups, subgroups, cosets, Lagrange's theorem and its applications. **(Lectures: 25)**

Unit-II: Properties of permutations, even and odd permutations, symmetric group, alternative group, cyclic groups and its properties. **(Lectures: 20)**

Unit-III: Normal Subgroup, Quotient or Factor groups; Group homomorphism- Definition and examples, Properties of homomorphism; Fundamental theorem on Group homomorphism, Isomorphism, Cayley's theorem. **(Lectures: 25)**

Unit-IV: Rings; definition and examples. Commutative and non-commutative rings:. Subrings, ideals, and quotient ring. Integral domains, division rings and fields (definitions and examples) **(Lectures: 20)**

Books Recommended

1. I. N. Heirstein, *Topics in Algebra*, Wiley; 2nd edition (2006)
2. S. Singh and Q. Zameerudin, *Modern Algebra* , Vikas Pub. House. Pvt Ltd. (2006)
3. V. K. Khanna and S. K. Bhambri, *A Course in Abstract Algebra*, Vikas Pub. House. Pvt Ltd. (2017)

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MAT-CC-232
Differential Equations
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The main objective of this course is to introduce the students to the exciting world of differential equations and their solutions methods.

Course Learning Outcomes: The course will enable the students to learn basics of differential equations and methods for solving the equations.

Unit-I: Order and degree of ordinary differential equation, formation of differential equation, General solution, variable separable form, Homogeneous differential equations, Equation reducible to Homogeneous equation from. **(Lectures: 15)**

Unit-II: Exact differential equations, equation reducible to exact form, Integrating factors, rules to find an integrating factor. Linear equation (including Bernoulli's equation and other simple cases reducible to reducible to linear), First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. **(Lectures: 30)**

Unit-III: Linear differential equations second order with constant coefficients. Linear homogenous equations with constant coefficients, Linear non-homogenous equations, the method of variation of parameters, Simultaneous differential equations, Total differential equations. **(Lectures: 30)**

Unit-IV: Introduction to partial differential equations, concept of linear and non-linear partial differential equations, Formation of partial differential equations. **(Lectures: 15)**

Books Recommended:

1. S. L. Ross, *Differential Equations*, 3rd Ed., Wiley; 3rd edition , (2007).

2. R. Bronson & V. Gejji, *Differential Equations*, McGraw Hill Education; 3rd edition (2017).

3. M. D. Raisinghannia, *Ordinary and Partial Differential Equation.* S. Chand and Co. (2020)

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MAT-CC-233
Statics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The prime objectives of this course are to acquaint students about the system of coplanar forces, resultant forces, to determine the centre of gravity of a body and to measure the frictional forces.

Course Learning Outcomes: After completion of the course, students will be able to understand basic components related to coplanar forces, centre of gravity and frictional forces acting on a body.

Unit – I: Coplanar forces: Resultant and Components, Parallelogram of forces, triangle law of forces, converse of triangle law of forces, Lami's Theorem and its converse, parallel forces, moment of a force about a point and an axis. Couple, resultant of a system of forces. Equilibrium of coplanar forces, system of coplanar forces reducible to a single force and a couple. **(Lectures: 40)**

Unit – II: Centre of Gravity: Definitions, Conditions of equilibrium, centre of gravity of a plane area, arc and a sector of a curve, centre of gravity of solids and surface of revolution, centre of gravity of areas bounded by a curve with applications. Catenary. **(Lectures: 25)**

Unit – III: Friction: Idea of Friction, laws of friction, angle of friction, coefficient of friction, equilibrium on rough planes and inclined planes. **(Lectures: 25)**

Books Recommended:

1. S. L. Loney, *The elements of Statics and Dynamics* (Part-I), Arihant Publications (2016).
2. A.S. Ramsay, *Statics*, Cambridge University Press, (2009)

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MAT-CC-241
Particle Dynamics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The main objectives of this course are to explore the understanding to the real world problems on different physical bodies via calculus. It emphasizes knowledge building for applying mathematics in physical world.

Course Learning Outcomes: After completion of the course, students will be able to understand the basic terms of the describing the motion of particles.

Unit – I: Kinematics: Components of Velocity and Acceleration in Cartesian, Radial and Transverse, Tangential and Normal forms. Angular velocity and acceleration. Motion in a straight line under inverse square law and variable accelerations, Simple Harmonic Motion (SHM), Elastic strings and Hook's law. **(Lectures: 40)**

Unit – II: Motion in Plane: Projectiles on a plane and on an inclined plane with Range and Time of flights.Motion in resisting medium (simple cases only). Ideas of Kinetic and Potential Energies, Work done, Principle of conservation energy with simple examples. **(Lectures: 25)**

Unit – III: Central orbits: Motion of a particle under central force, Differential Equation of Central Orbit in Polar and Pedal forms, Apse, Apsidal distance and Apsidal angle on a central orbit. Newton's law of gravitation, planetary orbit and Kepler's law. **(Lectures: 25)**

Books Recommended:

1. S. L. Loney, *The elements of Statics and Dynamics* (Part-II), Arihant Publications (2016).
2. A.S. Ramsay, *Dynamics*, Cambridge University Press, (2009)

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MAT-CC-242
Finite Differences and Numerical Analysis
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at comprehending various computational techniques to find approximate value for possible root(s) of non-algebraic equations. It also aims at introducing the methods of interpolating a data. It also includes numerical integration techniques.

Course Learning Outcomes: The course will enable the students to:
(i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable up to a certain given level of precision.
(ii) Know interpolation techniques to compute the values for a tabulated function at points not in the table.
(iii) Integrate a definite integral that cannot be done analytically.
(iv) Find numerical differentiation of functional values
(v) Solve differential equations that cannot be solved by analytical methods.

Unit I: Differences, Relation between differences and derivatives of polynomials, Factorial notation, Newton's forward and backward interpolation formula (including proof), Inverse Interpolation. Divided differences: Newton's and Lagrange's divided differences formulae. Central differences: Gauss's, Stirling's and Bessel's interpolation formulae. **(Lectures: 45)**

Unit II: Numerical differentiation. Numerical integration. A General Quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson's one third and three eight rule, Weddle's rule. **(Lectures: 15)**

Unit III: Least square method of curve fitting; fitting of straight line, power function, polynomial functions of second and higher degrees and exponential functions. **(Lectures: 15)**

Unit IV: Errors in Numerical computation, Polynomial and Transcendental equations. Nature and location of roots of Polynomial equations, Methods of solving transcendental equations: graphical method and Newton-Raphson method. **(Lectures:15)**

Books Recommended:

1. M. K. Jain, S.R.K. Iyengar & R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, (2007).
2. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, (2007).
3. S. S. Sastry, *Introductory Methods of Numerical Analysis*, Prentice hall of India, (2005).

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Rono Hills, Doimukh (A.P.)

MAT-CC-243
Complex Analysis
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: This course aims to introduce the basic ideas of algebra and properties of complex number and functions of complex variables.

Course Learning Outcomes: Completion of the course will enable the students to:
(i) Learn basic properties of complex numbers and complex functions, significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.
(ii) Learn some elementary functions and can evaluate the contour integrals.
(iii) Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula.
(iv) Expand some simple functions as their Taylor series.

Unit-I: Properties of complex numbers, regions in the complex plane. Functions of complex variable. limits, limits involving the point at infinity and L' Hospital's rule. Continuity and uniform continuity of complex functions. **(Lectures: 15)**

Unit-II: Derivatives, differentiation formulae, analytic functions, Cauchy-Riemann equations, necessary and sufficient conditions for differentiability. Harmonic functions and harmonic conjugate. Exponential function, logarithmic function and trigonometric function. **(Lectures: 30)**

Unit-III: Contour, contour integration, upper bounds for moduli of contour integrals and ML- inequality, change of variable, simply and multiply connected regions. Cauchy's theorem and Cauchy-Goursat theorem and consequences. **(Lectures:25)**

Unit-IV: Cauchy integral formula, Cauchy integral formula for higher derivatives and examples. Convergence of series, radius and domain of convergence, Taylor series and its examples.
(Lectures: 20)

Books Recommended

1. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw Hill Education; 8th edition (2017)

2. M. R Spiegel, *Theory and Problems of Complex Variables*, Schaum's Ouline Series, McGraw Hill (1981).

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MAT-CC-351
Metric Space
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at providing the basic ideas of different concepts of real analysis in abstract setting, for examples, distance function, neighbourhood, interior, closure, subspace, sequences and their convergence, continuity, compactness, connectedness etc. pertaining to metric space.

Course Learning Outcomes: The course will enable the students to:

(i) Understand the distance functions in abstract setting, and decide whether given functions are or are not metrics.
(ii) Decide whether sequences converge, and find the limits in an abstract spaces.
(iii) Correlate these concepts to their counter parts in real analysis.
(iv) Discover whether examples of metric spaces are complete using Cauchy sequences.

Unit–I: Distance functions, Metric Spaces: Definition and Examples, Open and closed sphere, interior point, interior of a set, open set and related theorems, closure point and closure of a set, Dense and nowhere dense sets, Limit point, derived sets, closed sets and their properties. **(Lectures: 25)**

Unit–II: Sequences and convergence: Definition in terms of N and ϵ, Examples, Basic properties: uniqueness of limit, equivalence of $x_n \to x$ with $d(x_n, x) \to 0$ in **R,** continuous functions: Definitions in terms of ϵ and δ, and in terms of sequences, Relation with closed sets and open sets, Uniform continuity, Test of function for uniform continuity. **(Lectures: 30)**

Unit–III: Cauchy sequence, complete metric space and examples, Cantor's intersection Theorem, Baire's Category theorem. **(Lectures: 15)**

Unit–IV: Connectedness, Connected subsets of **R**, Connectedness and continuous mappings, Compactness: Bolzano-Weierstrass Property, Bolzano-Weierstrass Theorem, Sequentially compact metric space and compactness of metric spaces, Heine-Borel Theorem. **(Lectures: 20)**

Books Recommended:

1. G. F. Simmon, *Introduction to Topology and Modern Analysis*, Tata McGraw Hill. New Delhi (2004).

2. J. R. Monkres, *Topology*, Pearson Education India; 2nd edition (2015)

3. S. Lipschutz, *General Topology*, McGraw-Hill Education; 1st edition (2011)

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MAT-CC-352
Linear Algebra
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The objective of this course is to introduce the fundamental theory of vector spaces, linear transformations, eigenvalues and eigenvectors.

Course Learning Outcomes: The course will enable the students to:
i) Learn about the concept of linear independence of vectors over a field, basis and the dimension of a vector space.
ii) Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation and the change of coordinate matrix.
iii) Compute characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces.

Unit-I: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Sums and direct sums.
(Lectures: 25)

Unit-II: Linear transformations, null space, range, rank and nullity of a linear transformation, dimension theorem, singular and non-singular linear transformations and isomorphism. Algebra of linear transformations, Matrix representation of a linear transformation and change of basis matrix.
(Lectures: 30)

Unit-III: Characteristic polynomial of matrices, eigenvalues and eigen vectors. Diagonalization. Cayley-Hamilton theorem and its use in finding the inverse of a matrix. **(Lectures: 20)**

Unit-IV: Linear functional, Dual Space, Dual Basis, Double Dual. Annihilators and transpose of a linear mapping. **(Lectures: 15)**

Books Recommended:

1. K. Hoffman & R. A Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., (1971).
2. S. Lipschutz, *Beginning Linear Algebra*, McGraw Hill; First edition (2020)

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MAT-CC-361
Advanced Calculus
Credit: 6 (L-5, T-1, P-0)
Total Hours: 90

Course Objectives: The course aims at introducing the concepts of functions of several variables. It also includes introduction to improper integrals and multiple integrals. Some applications of multiple integrals are also included.

Course learning outcomes: After the course, the student will be able to:
(i) Understand the notion of functions of several variables and partial derivatives, in particular.
(ii) Find the maxima and minima of a given function of two or more variables.
(iii) Become familiar with the applications of Double and Triple integrals.
(iv) understand the existence and convergence of improper integrals.

Unit I: Improper integrals, types of improper integrals and their convergence, Comparison tests for convergence, Cauchy's test for convergence, Absolute Convergence, Gamma function, Beta function. **(Lectures: 25)**

Unit II: Functions on two or more variables, implicit and explicit functions, Limits and Continuity of functions of two variables. Partial derivatives, Homogenous functions, Euler's theorem on homogenous function, total derivatives, Differentiation of implicit function. **(Lectures: 25)**

Unit III: Change of Variables, Jacobian and its properties, Taylor's Theorem, Extreme Values: Maxima and Minima, Lagrange's method of undetermined Multipliers, Differentiation under the integral sign. **(Lectures: 20)**

Unit IV: Multiple integral: Double and triple integrals, Change of order of integration, Change of variables in multiple integral, Application of multiple integral: Area enclosed by Plane Curves, Area of curved surface, and volume of solids. **(Lectures: 20)**

Books Recommended

1. S.C. Malik & S. Arora, *Mathematical Analysis*, New Age International Publishers, (2010).

2, W. Rudin, *Principles of Mathematical Analysis*, McGraw Hill Education; Third edition (2017)

2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, (1965)

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MAT-CC-362
Number Theory
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 60

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes: This course will enable the students to:
(i) Learn about some fascinating discoveries related to the properties of prime numbers
(ii) Know about number theoretic functions and their properties.
(iii) Solve linear and system of linear congruence equations.

Unit-I: Well-Ordering Principle, Divisibility, Division Algorithm, Greatest Common Divisor, Least Common Multiple, Primes, Fundamental Theorem of Arithmetic and applications.

(Lectures: 25)

Unit-II: Linear Diophantine Equation,. Definition of Congruence and Properties. Linear Congruence, Chinese Remainder Theorem. **(Lectures: 20)**

Unit-III: Complete Residue System, Reduced Residue System, Euler's Phi Function, Euler's Theorem, Fermat's Little Theorem and Wilson's Theorem and applications. **(Lectures: 20)**

Unit-IV: Number theoretic functions, sum and number of divisors, Mobius function, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function.

(Lectures: 25)

Books Recommended:

1. D. M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGrawHill, Indian reprint, (2007).
2. N. Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, (2007).
3. I. Niven, H. S. Zuckerman, & H. L. Montgomery, An Introduction to theory of numbers, Wiley; 5th edition (2008)

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Discipline Specific Elective (DSE)

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MAT-DE-351
Discrete Mathematics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at introducing the concepts of ordered sets, lattices, sublattices and homomorphism between lattices. It also includes introduction to modular and distributive lattices and Boolean algebra. It further includes introduction of graph theory.

Course learning outcomes: After the course, the student will be able to:
(i) Understand the notion of ordered sets.
(ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphism between lattices.
(iii) Become familiar with Boolean algebra, Boolean homomorphism,
(iv) get acquainted with the basics of graph theory.

Unit I: Mathematical induction, Principle of inclusion and exclusion, Pigeonhole principle, Generating Functions, Partitions, Recurrence Relation, Generating Function from Recurrence Relation.
(Lectures: 20)

Unit II: Partial Ordering, Properties of ordered sets, Order isomorphism, Hasse-diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements. Lattices, Sublattices, Products and homomorphisms, modular and distributive lattices. **(Lectures: 20)**

Unit III: Boolean Algebras, De Morgan's laws, Boolean homomorphism, Boolean function, Sum of product and Product of Sums form, Normal forms and canonical forms, Logic gates and Logic Circuits.
(Lectures: 25)

Unit-IV: Graphs: Basic concepts, subgraph, walk, path, circuits, Connectedness, complete graph, Bipartite graphs, Isomorphism in Graphs, Trees, spanning trees, weighted graph and shortest spanning tree. **(Lectures: 25)**

Books Recommended:

1. S.K. Sarkar, *A Textbook of Discrete Mathematics*, S Chand & Co. (2003).

2. S. Lipschutz & M.L. Lipson, *Discrete Mathematics*, Schaum's series, Tata McGraw Hill, (2005).

3. N. Deo, *Graph theory with applications to Engineering and Computer Science*, PHI Learning, (1979).

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MAT-DE-352
Dynamical System
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Objectives: After going through this course the students will be able to discuss the qualitative properties of difference/differential equations.

Course Learning Outcomes: After completion of the course, students will be able to understand main features of dynamical systems, particularly as they arise from systems of ordinary differential equations as models in applied mathematics and stability and dissipative systems.

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Unit – I: Introduction, A Geometrical way of Thinking, Fixed Points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness Theorem (Statement only), Examples. Bifurcations, Saddle-Node Bifurcation, Transcritical Bifurcation. **(Lectures: 25)**

Unit – II: Introduction, Investigation of Differential Equations via its Direction Field, Linear Systems, Phase Plane, Classification of Fixed Points of Non-linear Systems by Linearization, Examples.

(Lectures: 25)

Unit – III: Limit Cycles, Gradient System, Liapunov Functions, Dulac's Criteria, Poincare-Bendixon Theorem, Lorenz System and its Properties, Chaos, Necessary Condition for Chaos, Examples.

(Lectures: 20)

Unit – IV: Maps and Flow, Composition of Maps, Orbits, Fixed Points, Stable and Unstable Fixed Points, Basin of Attraction and Basin Boundary, Linear Stability Analysis, Cobweb Diagram, Examples.

(Lectures: 20)

Books Recommended

1. S. H. Strogatz, *Nonlinear Dynamics and Chaos*, Sarat Book Dist, Kolkata, (2014)
2. G.C. Layek, *An Introduction to Dynamical Systems and Chaos*, Springer (2015)

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MAT-DE-353
Differential Geometry
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of these units is to introduce basic concepts of the Planetary motion, Celestial Sphere and Time to connect with Universe.

Course Learning Outcomes: After completion of the course, students will be able to understand about different geometrical figures and their representation in mathematical equation. This course help students toe equation of normal , binormal and tangent to a curve.

Unit – I: Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret – Frenet formulae.Osculating circles, Osculating circles and spheres. Existence of space curves.

(Lectures: 35)

Unit – II: Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamentalforms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula,Conjugate and Asymptotic lines. **(Lectures: 35)**

Unit – III: Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature.

(Lectures: 20)

Books Recommended:

1. T. J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, (2012).

2. B. O.Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, (2006).

3. S. Lang, *Fundamentals of Differential Geometry*, Springer, (1999).

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MAT-DE-354
Hydrostatics
Credit:6 (L-5, T-1, P-0)
Total Lectures: 90

Objectives: The main objective of the course is to make students familiar with basic concepts and principles in hydrostatics and their application in solving related problems.

Course Learning Outcomes: After completion of the course students will be able to understand basic concepts of hydrostatics and its various applications in Physical Sciences.

Unit I: Fluid Pressure**:** Introduction, Fluid Pressure and related theorems, Density and specific gravity, Theorems on fluid pressure under gravity, Rate of variation of pressure, Differential equation of pressure, Condition of equilibrium, Equi-pressure surfaces and lines of force, Curves of equi-pressure and equi-density, Examples. **(Lectures: 35)**

Unit II: Resultant Pressure and Centre of Pressure: Resultant fluid pressure and related theorems, Centre of pressure, Determination of centre of pressure of parallelogram, triangle, circle under different conditions, Examples, Thrust on curved surfaces, Examples. **(Lectures: 35)**

Unit III: Equilibrium and Stability of Floating Bodies: Condition of equilibrium of floating bodies, Examples, Unstable and Neutral equilibrium, Determination of Meta centre, Examples.
(Lectures: 20)

Books Recommended:

1. M. Ray and H.S. Sharma: *A Text Book of Hydrostatics*. S. Chand & Company Ltd, New Delhi (2000).

2. A. S. Ramsey: *Hydrostatics*, Cambridge University Press (2017).

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MAT-DE-355
Spherical Trigonometry
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The main objective of this course is to provide the basic ideas of spherical triangles, Napier's rule of circular parts and area of Spherical triangle that are helpful in understanding their applications.

Course Learning Outcomes: This course will enable the students to learn about relationship between trigonometric functions of the spherical polygons defined by a number of intersections great circles. This course will helpful for calculations in the study of in astronomy, geodesy and navigational

Unit – I: Introduction- Section of a sphere by a plane, Great and small circles, number of great circles through two points, shortest arc joining two points, Axis and poles, properties of poles, Spherical radius, Angular distance, Two great circles bisects each other, Secondaries, Length of the arc of a small circle, Spherical triangles, Angles of a spherical triangle, Relation between spherical angle and right angles, Properties of spherical and polar triangles. **(Lectures: 35)**

Unit – II: Fundamental Formulae- Sine and Cosine formula, General proof of the cosine formula, Supplemental cosine formula, Formulae for half angles, Formulae for half sides, Sine-cosine formula, Supplemental sine-cosine formula, Cotangent formulae, Napier′s analogies, Delambre′ analogies.
(Lectures: 30)

Unit – III: Right angled triangles: Right angled triangles, Napier′s rule to write all formulae of right angled triangle, Lune, Area of spherical triangle, Cagnoli′s theorem, L′Huilier′s theorem.
(Lectures: 25)

Books Recommended:

1. I Todhunter, *Spherical Trigonometry*, MJP Publishers (2008)
2. D. S. Pandey & S. K. Dubey, *A text book of spherical trigonometry and spherical astronomy*, Swastik Publication (2009)

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MAT-DE-356
Linear Programming
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at providing the basic ideas of different tools and techniques in solving linear programming problems.

Course Learning Outcomes: The course will enable the students to:
(i) understand about the optimization problems and its applications towards different fields.
(ii) decide whether a solutions is a optimal solution or not.
(iii) correlate these concepts to their counter parts in real world problems.

Unit–I: Hyperplanes and Hyperspheres, Convex Sets and Their Properties: Convex Combination, Convex Hull, Convex Polyhedron and Simplex, Extreme Point, Supporting and Separating Hyperplanes, Convex Function. **(Lectures: 10)**

Unit–II: Formulation of Linear programming problem (LPP), optimal solutions and graphical interpretation of optimality, Solving LPP using graphical methods. **(Lectures: 15)**

Unit–III: Slack and Surplus Variables, Canonical and Standard forms of LPPs, Basic solution, Basic feasible solutions (BFS): algebraic interpretation of extreme point, Reduction of a Feasible solution to a Basic Feasible Solution, Relationship between extreme points and corresponding BFS, Adjacent extreme points and corresponding BFS along with examples, Fundamental theorem of LPP and its illustration through examples, Condition of Optimality. **(Lectures: 15)**

Unit–IV: To get the initial BFS, Simplex Methods, Unbounded and alternative Solution, illustration through examples. **(Lectures: 25)**

Unit–V: Artificial variables and its interpretation in context of feasibility, Two phase and Big-M methods and illustration, Degeneracy and its consequences including cases of cycling, Introduction to duality & formulation of dual LPP for different models through examples, Duality theorems and their interpretations, Solution of LPP using duality. **(Lectures: 25)**

Books Recommended:

1. M. H. K. Swarup & P. K. Gupta and Mon Mohan: *Operation Research*, Sultan Chand & Sons. (2017)
2. S K. Sharma, *Linear programming*, Cyber Tech Publications (2009)
3. F. S. Hillier & G. J. Lieberman: *Introduction to Operation Research SIE*, McGraw Hill Education; Tenth edition (5 July 2017)

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MAT-DE-357
Hydrodynamics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The main objectives of this course are to introduce the elementary concepts on various fluids, Fluid Pressure, Gas, Equilibrium conditions and Kinematics that involves in real world physical problems.

Course Learning Outcomes: This course will enable the students to learn different forces acting on various types of fluids. This course will help the students to know about the effect of temperature and pressure on fluids motion.

Unit – I: Introduction: Definition of Ideal and Real fluids, Homogeneous and Heterogeneous fluids, Pressure, density, viscosity. Newtonian and Non-Newtonian fluids. Scalar and vector fields, flow fields, two dimensional and three dimensional flows, Anisymmetric flow, line of flow. **(Lectures: 25)**

Unit – II: Gas: Pressure of gases, The Atmosphere, Relation between pressure, density and temperature, Pressure in an isothermal atmosphere, Adiabatic gas, Atmosphere in convective equilibrium. Rotating fluids. Examples. **(Lectures: 25)**

Unit – III: Kinematics of Fluid: Pressure, Density, Viscosity, Newtonian and Non-Newtonian Fluids, Scalar and Vector Fields, flow field, Description of Fluid Motion: Lagrangian method, Eulerian method, Relation between Eulerian and Lagrangian methods. Variation of Flow Parameters in Time and Space: Steady and Unsteady Flow, Uniform and Non-uniform Flows. Material Derivative and Acceleration: Temporal (local) derivative, Convective derivative. Rotational, irrotational flow and velocity potential.Velocity of a fluid particle at a point. Examples. **(Lectures: 40)**

Books Recommended

1. M. D. Raisinghania, *Fluid Dynamics*: With Hydrodynamics, S Chand & Co. 5th edition (2003).

2. H. Lamb, *Hydrodynamic*s, Dover Publications Inc.; 6th edition (2009).

3. S. Swarup, *Hydrodynamics*, Krishna Prakashan Mandir, Meerut (1996).

4. B. D. Sharma, *Hydrostatic*, Krishna Prakashan Mandir, Meerut (1996).

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MAT-DE-361
Spherical Astronomy
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of the course is to introduce basic concepts of the planetary motion, Celestial sphere and time to connect with Universe.

Course Learning Outcomes: This course will enable the students to learn about celestial coordinate systems, motion of planets and governing laws.

Unit – I Planetary motion: Annual motion of the Sun, planetary motion, synodic period, orbital period, Area integral, Kepler's law, Anomalies, Kepler's Equations, Kepler's law from Newton's law of gravitation, orbital equation, velocity of a planet in its orbit, components of linear velocity perpendicular to the radius vector and to the major axis, direct and retrograde motion in a plane.

(Lectures: 35)

Unit– II Celestial sphere: Different System of Co-ordinates, Phenomenon of rising and setting of stars, Twilight, Solar system, Two body problem, Equation of relative motion. **(Lectures: 30)**

Unit– III Time: Sidereal Time, Tropical Year, The mean Sun, The equation of Time, The equation of time vanishes Four times in a year (Proof), Seasons, Lengths of Seasons. **(Lectures: 25)**

Books Recommended:

1. W.M. Smart and R. M. Green, *Spherical Astronomy*, Cambridge University Press; 6th edition, (1977).

2. G .S. Malik, *Spherical Astronomy*, Kedar Nath Ram Nath, Meerut (1997).

3. W. M. Smart & R. M. Green, *Textbook on Spherical Astronomy*, Cambridge University Press; 6th edition (1977)

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MAT-DE-362
Probability and Statistics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: To make the students familiar with the basic statistical concepts and tools needed to study situations involving uncertainty or randomness. The course intends to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

Course Learning Outcomes: This course will enable the students to:
(i) Learn about basic concepts of probability, probability density and moment generating functions.
(ii) Learn about distributions to study the joint behavior of two random variables.
ii) Know about univariate distributions such as Binomial, Poisson, and Normal distributions.

Unit-I: Sample space, Events, probability axioms, Addition Law of probability, Conditional probability, Multiplication Law of probability and independent events. Baye's theorem. **(Lectures: 25)**

Unit-II: Random variable (discrete and continuous), cumulative distribution function, probability mass/density functions. Various measures of central tendency, dispersion, skewness and kurtosis for continuous distributions. Joint cumulative distribution function, joint probability density functions, marginal and conditional distributions. **(Lectures: 25)**

Unit-III: Mathematical expectation, moments, moment generating function. Expectation of function of two random variables, conditional expectations, independent random variables. Characteristic function. **(Lectures: 20)**

Unit-IV: Probability distributions and their properties: Binomial distribution, Poisson distribution and Normal distribution. **(Lectures: 20)**

Books Recommended:

1. S. C. Gupta & V. K. Kapoor, *Fundamentals of Mathematical Statistics*, S. Chand & Sons (2020).

2. M. Spiegel , J.Schiller , R. A. Srinivasan & D. Goswami, *Probability and Statistics*, McGraw Hill education; 3rd edition (2017)

3. R. V. Hogg, J. W. McKean & A.T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, (2007).

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MAT-DE-363
Financial Mathematics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The objective of this course is to acquaint students with knowledge of a range of mathematical and computational techniques that are required for a wide range of quantitative positions in the financial sectors and to develop student appreciation of the major issues involved in financial mathematics

Course Learning Outcomes: This course will enable the students to:

(i) Build quantitative models of financial mathematics/industries.

(ii)Apply models to obtain information of practical value in the financial mathematics.

Unit-I: Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds. (**Lectures: 45)**

Unit-II: Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index. **(Lectures: 45)**

Books Recommended:

1. D. G. Luenberger, *Investment Science*, Oxford University Press, Delhi, (1998).

2. J. C. Hull, *Options, Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian (2006).

3. S. Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, (2003).

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MAT-DE-364
Computational Group Theory
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objective: To develop computational approach toward group structure and classifications.

Course Learning Outcomes: This course will enable the students to:

(i) Classify groups up to an isomorphism.

(ii) Construction of new groups

(iii) Understand some of the most important result in Group theory.

Unit I: Cyclic groups, finite groups, types of products(internal and external) and its properties, classification of groups, finite abelian groups, fundamental theorem on finite abelian groups. **(Lectures: 30)**

Unit II: Introduction to group action, orbit and stabilizer, Stabilizer-Orbit theorem, Normalizer and centralizer, and their properties. **(Lectures: 30)**

Unit III: Congugacy classes, class equations with special reference to symmetric groups, sylows theorem and its applications. **(Lectures: 30)**

Books Recommended:

1. I. N. Heirstein, *Topics in Algebra*, Wiley; 2nd edition (2006)
2. S. Singh and Q. Zameerudin, *Modern Algebra* , Vikas Pub. House. Pvt Ltd. (2006)
3. V. K. Khanna and S. K. Bhambri, *A Course in Abstract Algebra*, Vikas Pub. House. Pvt Ltd. (2017)
4. J. A Gallian, *Contemporary Abstract Algebra*, 4th ED., Narosa, (1999)

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MAT-DE-365
Integral Transform and Vector Calculus
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The objective is to provide concept of Laplace transform and Fourier Transform and Vector Calculus as a problem solving techniques.

Course Learning Outcomes: After completion of the course students will be able to know Laplace and Fourier transforms and its properties. Students will be able to apply the solve different types of ordinary differential equations using integral transforms. Students will be have basic concept of vector differentiations Gradient, divergence and curl, and applications.

Unit I: Laplace Transforms: Laplace Transforms of some elementary functions, Linearity property, First and second translational or shifting theorem. Change of scale property, Laplace transforms of derivatives Multiplication by powers of t, and related problems. **(Lectures: 25)**

Unit II: The inverse Laplace transforms: Definition, some inverse Laplace transforms properties of inverse Laplace transform, inverse Laplace transforms of derivatives, Multiplication by s, Convolution property, partial fraction method, Complex inversion formula. Application to ordinary differential equation. **(Lectures: 20)**

Unit III: Fourier transform, Fourier integral, Sine and Cosine transform, Inverse Fourier Transform, Application of Fourier Transform to Ordinary Differential equations. **(Lectures: 20)**

Unit-IV: Vector Calculus: Scalar triple product, Vector triple product. Ordinary and and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence, curl, and applications. **(Lectures: 25)**

Books Recommended:

1. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.
2. M. R. Spiegel, *Theory and problems of Laplace Transform*, Schaum's Series, Tata McGraw-Hill (2005).
3. J. K. Goyal & K. P. Gupta, *Laplace and Fourier Transforms*, PRAGATI PRAKASHAN (2016)
4. M. Spiegel, S. Lipschutz &, D. Spellman, *Vector Analysis*, McGraw Hill Education; 2nd edition (2017).

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MAT-DE-366
Fuzzy Sets and Fuzzy Logics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at providing the basic ideas of fuzzy sets and fuzzy logics with prospects in different aspects.

Course Learning Outcomes: The course will enable the students to:
(i) Understand about the distinction between fuzzy sets and fuzzy logics;
(ii) Correlate these concepts to their counter parts in real world problem.

Unit– I: Introduction to Fuzzy Sets: Basic definitions and comparison with crisp sets, α - level sets and support, distinction between probability and fuzzy sets theory, basic operations on Fuzzy sets, Different types of fuzzy sets, interval valued fuzzy sets, intuitionistic fuzzy sets. **(Lectures: 25)**

Unit–II: Extension principle for fuzzy sets and its properties, fuzzy complements, t- norms and t-conforms and its role in fuzzy operations, Dual triplets. Fuzzy numbers, Arithmetic with Fuzzy numbers. **(Lectures: 15)**

Unit–III: Overview of crisp relation, Fuzzy relations: Definitions and basic properties, Min-Max composition, Types of Fuzzy relation, special fuzzy relations. **(Lectures: 15)**

Unit–IV: Probability theory: Fuzzy measures, Evidence theory; belief measure, plausibility measure and necessity, measures, possibility distribution, possibility theory, probability of Fuzzy events, possibility theory versus probability theory. **(Lectures: 15)**

Unit–V: An overview of classical logic, Multi-valued logics, Linguistic variables, Linguistic modifiers, Truth, Propositions of fuzzy logic, Fuzzy quantifiers, Fuzzy implications. **(Lectures: 20)**

Books Recommended:

1. G. J. Klir & B. Yuan, *Fuzzy Sets and Fuzzy Logic Theory and Applications*, PHI, (1997)

2. H. J. Zimmermann, *Fuzzy Set Theory and its Applications*, 2ed, Kluwer Academic Publishers, (1996).

3. G. Bojadzieve & M. Bozadzieve, *Fuzzy Sets, Fuzzy Logic Applications*, World Scientific, (1995).

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Skilled Enhancement Courses

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MAT-SE-001
Fundamentals of Computers
Credit: 2 (L-1, T-0, P-0)
Total Lectures : 30

Course Objectives: The course aims at acquainting the students about the Basic structure and working of computers.

Course Learning outcomes: After the course, the student will be able to:

1. Understand how data are stored in computer.
2. Use technology ethically, safely, securely, and legally.
3. Identify and analyse computer hardware, software, and network components.
4. Make intelligent computer purchase decisions.

Unit 1: Number systems: Binary Number System, Octal number system, Hexadecimal number system, Inter conversion between number systems, Binary arithmetic. Introduction to Computer, Block Diagram of Computers, generations and classification of Computers, System Hardware, Memory, Input and Output Devices, Interaction between User and Computer. . **(Lectures: 15)**

Unit II: Software: System Software and Application Software, Operating System:types and functions of Operating Systems, Translators: Assembler, compiler and interpreter. Computer Networking, Types of Communication network, Internet and World Wide Web, Network security and its importance, Network security attacks and Solution. **(Lectures: 15)**

Books Recommended

1. E. Balaguruswamy, *Fundamentals of Computers*, McGraw Hill Education India, (2009).
2. P. Dey. & M. Ghosh.**,** *Computer fundamentals and programming in C*,2nd Ed**.**, Oxford University Press, (2013).
3. A. Goel, *Computer Fundamentals*, Pearson Education India, (2010).
4. V. Rajaraman V.& N. Adabala, *Fundamentals of computers*, 6th Ed., Prentice Hall India Learning, (2014).
5. V. Gupta, *Computer Concepts and C Programming*, Dreamtech Press, (2009).

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MAT-SE-003
Logic and Sets
Credit: 2 (L-1, T-0, P-0)
Total Lectures: 30

Objectives: The course aims at acquainting the students about the basic properties of sets and rules of inferences.

Course learning outcomes: After going through this course the students will be able to
(i) List the truth and falsity of a logical statement
(ii) Differentiate between a logical statement and an ordinary statement
(iii)Define and describe various properties of sets.

Unit-I: Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. **(Lectures: 15)**

Unit-II: Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

(Lectures: 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).

4. S. B. Bhoi, *A Text Book of Logic and Sets*, Educreation Publishing (2018)

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MAT-SE-005
Introduction to MATLAB
Credit: 2 (L-1, T-0, P-1)
Total Lectures: 45

Objectives: The main objective of the course is to make familiar with the mathematical software MATLAB, and have the knowledge of graphical representations of some the well known functions so that distinction between different functions can be recognized.

Course Learning Outcomes: The students will be enabled to

1. understand the use and importance's of MATLAB;
2. understand the basic operations of MATLAB;
3. write scripts and plotting of functions.

Unit I: Brief introduction, Installation, History and use of MATLAB, Key features, MATLAB window, Command window, Workspace, Command history Setting directory, Working with the MATLAB user interface, Basic commands, Assigning variables, Operations with variables; **Data files and Data types:** Character and string, Arrays and vectors, Column vectors, Row vectors; **Basic Mathematics**: BODMAS Rules, Arithmetic operations, Mathematical and logical operators, Solving arithmetic equations, Operations on matrix, Trigonometric functions. **(Lectures: 7)**

Unit II: M files: Working with script tools, Writing Script file, Executing script files, The MATLAB Editor; **Plots:** Plotting vector and matrix data with labelling and editing, Basic Plotting Functions (2D), Plotting Multiple Data Sets in One Graph with Line Styles and Colors, Graphing Imaginary and Complex Data, Figure Windows, Displaying Multiple Plots in One Figure, Controlling the Axes, **3D plots**: Creating Mesh and Surface, About Mesh and Surface Visualizing, Subplots; Writing programs with logic and flow control, Writing functions, **Loops and Conditional:** Conditional Control — if, else, switch; Loop Control — for, while, continue, break, return, **Functions**: Writing user defined functions, Built in Function, Function calling, Return Value, Types of Functions. **(Lectures: 8)**

Practical

In consonant with Unit I and Unit II. **(Lectures: 30)**

Recommended Books:

1. P. I. Kattan, *MATLAB For Beginners*: *A Gentle Approach*, Create Space Independent Publishing Platform (2008)

2. D. J Higham and Nicholas J Higham, MATLAB Guide, third edition, SIAM (2016)

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MAT-SE-007
Introduction to MATHEMATICA
Credit: 2 (L-1, T-0, P-1)
Total Lectures: 45

Objectives: *Mathematica* is a powerful coding language in science and engineering computing. The objective of the course is to acquaint students with mathematical computation with using *Mathematica* software.

Course learning outcomes: After completion of the course students will be enabled to do
(i) Basic mathematical computations of functions, differentiation and integration of functions.
(ii) Display matrix and its operations.
(iii) Solution of linear, simultaneous equations, differential equations using MATHEMATICA.

Unit-I: Introduction to Mathematica and to the Wolfram Language. Basic components of Mathematica and entering inputs. Variables and functions, polar coordinates, complex numbers. Trigonometric, logarithmic and exponential functions. Plotting of functions in 2D and 3D. Numerical and symbolic computations.

Evaluation of limit, derivatives, maximum and minimum values of functions. Indefinite and definite integrations of functions. Sequence, sums and series. Matrix display and calculation of transpose, determinant, inverse, rank, characteristics polynomial, Eigen values, Eigenvectors and trace. Plotting of curves. Solution of algebraic equation, simultaneous linear equations and differential equations.

(Lectures: 15)

Practical

Practical inconsonant with Unit-I. **(Lectures: 30)**

Recommended Books:

1. Eugene Don, *Mathematica*, Schaum's Outline of Mathematica, Second Edition (2009).

2. B. F. Torrence and E. A. Torrence: *The Student's Introduction to MATHEMATICA*, Cambridge University Press; 2nd edition (29 January 2009)

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MAT-SE-002
R Programming
Credit: 2 (L-1, T-0, P-1)
Total Lectures: 45

Course Objectives: This course aims at familiarizing students with basics of statistical software **R**. Data entry and summary commands will be studied in **R**. Graphical representation of data shall also be explored.

Course Learning Outcomes: This course will enable the students to:
(i) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**
(ii) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data analysis.

Unit-I: The Statistical Programming Language: R as a calculator, Explore data and relationships in **R.** Reading and getting data into **R:**Combine and scan commands, Types and structure of data items with their properties, Manipulating vectors, Data frames, Matrices and lists, Viewing objects within objects, Constructing data objects and conversions.
Data Analysis with R: Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists, Summary tables, Stem and leaf plot, Histograms, Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and bar charts, Copy and save graphics to other applications. **(Lectures: 15)**

Practical

Practical with consonant with Unit-I to II. **(Lectures: 30)**

Books Recommended:

1. M. Gardener, *Beginning R*: *The Statistical Programming Language*, Wiley. (2012).

2. J. Verzani, *Using R for Introductory Statistics* (2nd ed.). CRC Press, Taylor & Francis Group. (2014).

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MAT-SE-004
Programming in C
Credit: 1 (L-1, T-0, P-1)
Total Lectures: 45

Course Objectives: The course aims at introducing the concepts of C Programming.

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of c Programming.
ii) code a program on their own.
iii) Solve problems which cannot be solved analytically.

Unit I: Introduction to C Programming: Basic structure, constants, variables, Data types, operators and expressions, Control statements: if statement, switch statement, conditional operator statement and goto statement. Looping, nested loops continue and break statements. Arrays and functions.

(Lectures: 15)

Practical

Practical in consonant with the materials in Unit I. **(Lectures: 30)**

Books Recommended

1. E. Balaguruswamy, *Programming in ANSI C*, 8th Ed., McGraw Hill Education India, (2019).
2. P. Dey & and M. Ghosh**,** *Computer fundamentals and programming in C*,2nd Ed**.**, Oxford University Press, (2013)
3. V. Gupta , *Computer Concepts and C Programming*, Dreamtech Press, (2009).

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MAT-SE-006
LaTeX
Credit: 2 (L-1, T-0, P-1)
Total Lectures: 45

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation..

Course Learning Outcomes: After studying this course the student will be able to:

(i) Create and typeset a LaTeX document.

(ii) Typeset a mathematical document using LaTex.

(iii) Learn about pictures and graphics in LaTex.

(iv) Create beamer presentations.

Unit I: Getting Started with LaTeX: Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material.

Mathematical Typesetting with LaTeX: Accents and symbols, Mathematical typesetting (elementary and advanced)**:** Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Graphics and Beamer Presentation in LaTeX: Graphics in LaTeX, Simple pictures using PSTricks, Plotting of functions, Beamer presentation. **(Lectures: 15)**

Practical

Practical with consonant with Unit-I.. **(Lectures: 30)**

Books Recommended

1. D. Bindner & M. Erickson. *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC. (2011).

2. L. Lamport, *LaTeX*: *A Document Preparation System*, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint (1994).

3. M. R. C. van Dongen,, *LaTeX and Friends*. Springer-Verlag (2016).

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MAT-SE-008
Numerical Interpolation and Curve Fitting
Credit: 2 (L-2, T-0, P-0)
Total Lectures: 30

Objectives: The course aims at acquainting the students about the numerical techniques of data interpretations and approximations.

Course Learning outcomes: After going through this course the students will be able to
(i) Numerical methods of interpolation and extrapolations of data with equal and unequal intervals.
(ii) Fitting data to specific curve and approximation of values.

Unit-I: Finite differences –Interpolation Techniques: Newton-Gregory formula for forward and backward interpolations of equal intervals, Divided difference with unequal arguments, Newton's interpolation formula for unequal intervals and Lagrange's interpolation formula. **(Lectures: 20)**

Unit-II: Least square method of curve fitting; fitting of straight line, power function, polynomial functions of second and higher degrees and exponential functions. **(Lectures: 10)**

Books Recommended

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.
2. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
3. S.S. Sastry, *Introductory Methods of Numerical Analysis*, Prentice hall of India, 2005.

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Generic Elective Papers

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MAT-GE-001
Differential and Integral Calculus
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of this course is to introduce basic tools of calculus and geometric properties which are helpful in understanding their applications in real world problems.

Course Learning Outcomes: This course will enable the students to:
(i) Learn concepts of limit, continuity and derivatives of functions.
(ii) Learn different theorems related to continuous functions.
(iii) Learn basic concept of integration and its applications.

Unit-I: Limit and Continuity, Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions. **(Lectures: 30)**

Unit-II: Tangents and normals, Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series, Maxima and Minima, Indeterminate forms. **(Lectures: 30)**

Unit-III: Integration by partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals. Rectification of plane curves, area under plane curves, volume and surface areas of solid of revolution. **(Lectures: 30)**

Books Recommended:

1. T. G.B. Thomas and R.L. Finney, *Calculus* (13thed). Pearson Education, Delhi. Indian Reprint (2017).

2. H. Anton, I. Bivens, & S. Davis, Stephen . *Calculus* (10th ed.), Wiley India Pvt. Ltd., Delhi (2013).

3. S. Narayan & P. K. Mittal, *Differential Calculus*, S. Chand & Co Ltd; 15th edition (1942).

4. S. Narayan & P. K. Mittal, *Integral Calculus*, S. Chand & Co Ltd; 35th edition (2005)

5. B. C. Das & B. N. Mukherjee, *Differential Calculus*. U.N. Dhur & Sons Pvt. Ltd.; 57th edition (2019)

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MAT-GE-003
Discrete Mathematics
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at introducing the concepts of ordered sets, lattices, sublattices and homomorphisms between lattices. It also includes introduction to modular and distributive lattices and Boolean algebra. It further includes introduction of graph theory.

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of ordered sets.
ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphism between lattices.
iii) Become familiar with Boolean algebra, Boolean homomorphism,
iv) get acquainted with the basics of graph theory.

Unit I: Mathematical induction, Principle of inclusion and exclusion, Pigeonhole principle, Generating Functions, Partitions, Recurrence Relation, Generating Function from Recurrence Relation.
(Lectures: 25)

Unit II: Partial Order, Properties of ordered sets, Order isomorphism, Hasse-diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements. Lattices, Sublattices, Products and homomorphisms, modular and distributive lattices. **(Lectures: 20)**

Unit III: Boolean Algebras, De Morgan's laws, Boolean homomorphism, Boolean function, Sum of product and Product of Sums form, Normal forms and canonical forms, Logic gates and Logic Circuits.
(Lectures: 25)

Unit-IV: Graphs: Basic concepts, subgraph, walk, path, circuits, Connectedness, complete graph, Bipartite graphs, Isomorphism in Graphs, Trees. **(Lectures: 20)**

Books Recommended:
1. S.K. Sarkar, *A textbook of Discrete Mathematics*, S Chand & Sons, 2003.
2. S. Lipschutz & M.L. Lipson, *Discrete Mathematics*, Schaum's series, Tata McGraw Hill Edition, 2005
3. N. Deo, *Graph theory with Applications to Engineering and Computer Science*, PHI Learning (1979).

MAT-GE-005
Basic Statistics and Probability
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: To make the students familiar with the basic statistical concepts and tools needed to study situations involving uncertainty or randomness. The course intends to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

Course Learning Outcomes: This course will enable the students to:

i) Learn about basic concepts of probability, probability density and moment generating functions.

(ii) Learn about distributions to study the joint behavior of two random variables.

ii) Know about univariate distributions such as Binomial, Poisson, and Normal distributions.

Unit I: Frequency distribution, measures of central tendency, Measures of Dispersion: Standard deviation, Quartile deviation, co-efficient of variation, Skewness and Kurtosis. **(Lectures: 20)**

Unit II: Correlation and regression; Karl Pearson's co-efficient of correlation, Spearman Rank correlation co-efficient, regression lines and equations. **(Lectures: 20)**

Unit III: Probability; Basic terminology, Mathematical definition of probability, statistical probability, axiomatic approach of probability. Conditional probability, multiplication theorem of probability, independent events, multiplication theorem of probability for independent events. Baye's theorem. **(Lectures: 30)**

Unit IV: Theoretical Probability Distribution: Binomial, Poisson and Normal Distribution and their applications to simple problems. **(Lectures: 20)**

Books Recommended

1. S. C. Gupta & V. K. Kapoor, *Fundamentals of Mathematical Statistics*, S. Chand & Sons (2020).

2. M. Spiegel , J.Schiller , R. A. Srinivasan & D. Goswami, *Probability and Statistics*, McGraw Hill education; 3rd edition (2017)

3. R. V. Hogg, J. W. McKean & A.T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, (2007).

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MAT-GE-007
Coordinate Geometry
Credit: 6 (L-5, T-1, P-0)

Course Objectives: The primary objective of this course is to introduce the basic tools of two dimensional coordinate systems, general conics, and three dimensional coordinates systems. Also, introduces the vectors in coordinate systems with geometrical properties

Course Learning Outcomes: This course will enable the students to:

i) Transform coordinate systems, conic sections

ii) Learn polar equation of conic, tangent, normal and related properties

iii) Have a rigorous understanding of the concept of three dimensional coordinate systems

Unit-I: Change of Axes: Transformation of coordinates, Translation of axes, Rotation of axes, Removal of xy-terms and the first degree terms, Invariants. Pair of Straight lines: Homogeneous equations of second degree, Angle between a pair of lines, Bisectors of the angles between the pair of lines, Condition for the general equation of second degree to represent a pair of lines, pairs of parallel and perpendicular lines, points of intersection of a line and curve. **(Lectures: 25)**

Unit-II: Conic section; Parabola, hyperbola, and ellipse. General conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes. **(Lectures: 20)**

Unit-III: Introduction to three dimensional geometry: Straight lines and planes, Skew lines, Coplanar lines, Angle between two planes, Shortest distance between two lines and equations of shortest distance. Sphere: Plane section of a sphere, intersection of two spheres, sphere with a given diameter, Equation of a sphere through a given circle. **(Lectures: 25)**

Unit-IV: Cones and Cylinders: Definition, Equation of a cone with a conic as guiding curve, the right circular cone, its definition and equation. Definition and equation of cylinder, Definition and equation of right circular cylinder. **(Lectures: 20)**

Recommended Books:

1. R. M. Khan, *Analytical Geometry of two and three dimension and vector analysis*. New Central Book Agency (2012).

2. Anton, Howard, Bivens, Irl, & Davis, Stephen, *Calculus* (10th ed.). Wiley India Pvt. Ltd. Delhi. (2013).

3. E. H. Askwith, The Analytical Geometry of the Conic Sections, Nabu Press (2012)

4. R. J. T. Bell, Coordinate Solid Geometry, Macmillan, (1983)

5. S. Narayan & P. K. Mittal, *Analytic Solid Geometry*, S. Chand & Co. 17th edn. (2007).

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MAT-GE-002
Elementary Algebra
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory, matrices, determinant, along with algebraic structures like group and vector space to understand their connection with the real-world problems.

Course Learning Outcomes: This course will enable the students to:
(i) Learn how to solve the cubic and biquadratic equations, also learn about symmetric functions of the roots for cubic and biquadratic.
(ii) Employ De Moivre's theorem in a number of applications to solve numerical problems.
(iii) Recognize consistent and inconsistent systems of linear equations by the row echelon form of theaugmented matrix.
(iv) Recognize the mathematical objects that are groups and their properties.
(v) Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.

Unit I: Theory of Equations and Trigonometric: Fundamental Theorem of Algebra, Relation between roots and coefficients of equation, Solutions of cubic and biquadratic equations. De Moivre's theorem (both integral and rational index), Solutions of polynomial equations using trigonometry and De Moivre's theorem, Expansion for in terms of powers of in terms of cosine and sine of multiples of *x*. **(Lectures: 40)**

Unit II: Matrices: Matrices, types of matrices. Determinants, rank of a matrix, inverse of a matrix, and invariance of rank under elementary transformations. Reduction to normal form and echelon forms. Consistency and solutions of system linear equations in matrix form Ax=b. **(Lectures: 30)**

Unit III: Groups: Sets, relations, congruence and equivalence relation, functions, permutations, properties of permutations, Groups-examples and properties, Subgroup, order of a group, Lagrange theorem. **(Lectures: 20)**

Books Recommended:

1. J. Hall & P. Knight, *Higher Algebra* Arihant Publications; Sixth edition (2016)
2. R. Bronsons, *Matrix Operations*, McGraw-Hill Education; 1st edition (1988)
3. I. N. Heirstein, *Topics in Algebra*, Wiley; 2nd edition (2006)
4. V. K. Khanna and S. K. Bhambri, *A Course in Abstract Algebra,* Vikas Pub. House. Pvt Ltd. (2017)
5. M., Carl D., *Matrix Analysis and Applied Linear Algebra*. Society for Industrial and Applied Mathematics (Siam), (2000).

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MAT-GE-004
Differential Equations
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The main objective of this course is to introduce the students to the exciting world of differential equations and their solutions methods.

Course Learning Outcomes: The course will enable the students to learn basics of differential equations and methods for solving.

Unit-I: Order and degree of ordinary differential equation, formation of differential equation, General solution, variable separable form, Homogeneous differential equations, Equation reducible to Homogeneous equation from. **(Lectures: 20)**

Unit-II: Exact differential equations, equation reducible to exact form, Integrating factors, rules to find an integrating factor. Linear equation (including Bernoulli's equation and other simple cases reducible to reducible to linear), First order second degree equations. **(Lectures: 40)**

Unit-III: Linear differential equations second order with constant coefficients. Linear homogenous equations with constant coefficients, Linear non-homogenous equations, the method of variation of parameters, Simultaneous differential equations. **(Lectures: 30)**

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, (1984).

2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, (1967).

3. M. D. Raisinghannia, *Ordinary and Partial Differential Equation.* S. Chand and Co. (2020).

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MAT-GE-006
Modern Algebra
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course will develop an understanding of different types of abstract algebraic structures and its properties.

Course Learning Outcomes: This course will enable the students to:
(i) Recognize fundamental algebraic structures like group, rings, integral domain, field.
(ii) It will enable to students to learn how to prove theorems in abstract setting.

Unit-I: Groups and subgroups, Properties of groups. Cyclic groups and its properties. Normal Subgroup, Quotient or Factor groups. **(Lectures: 25)**

Unit-III: Group homomorphisms;Definition and examples, Properties of homomorphisms; Fundamental theorem on Group homomorphisms, Isomorphism, Cayley's theorem.
(**Lectures: 20)**

Unit-IV: Rings; definition and examples. commutative and non-commutative rings:. Subrings and ideals, quotient ring. Integral domains, division rings and fields (definitions and examples)
(**Lectures: 20)**

Unit-IV: Vector spaces, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, matrix representation of linear transformation. **(Lectures: 25)**

Books Recommended

1. I. N. Heirstein, *Topics in Algebra*, Wiley; 2nd edition (2006)
2. Surjeet Singh and Qazi Zameerudin, *Modern Algebra*, Vikas Publishing House Pvt Ltd; 8th Edn.(2006)
3. S. Lipschutz , *Beginning Linear Algebra*, McGraw Hill Education; 3rd edition (2020)
4. W. J. Gilbert , *Modern Algebra with Applications*, Wiley (2008)

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MAT-GE-008
Numerical Methods
Credit: 6 (L-5, T-1, P-0)
Total Lectures: 90

Course Objectives: The course aims at comprehending various computational techniques to find approximate value for possible root(s) of non-algebraic equations, solutions to simultaneous linear equations and ordinary differential equations.

Course Learning Outcomes: The course will enable the students to:
(i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable up to a certain given level of precision.
(ii)Solve system of linear equations using numerical methods.
(iii) Solve differential equations that cannot be solved by analytical methods.

Unit I: Differences, Relation between differences and derivatives of polynomials, Factorial notation, Newton's forward and backward interpolation formula.. Divided differences: Newton's and Lagrange's divided differences formulae **(Lectures: 25)**

Unit II: Numerical differentiation. Numerical integration; General quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson's one-third and three-eight rule, Weddle's rule.

(Lectures: 30)

Unit III: Errors in Numerical computation, Polynomial and Transcendental equations. nature and location of roots of Polynomial equations, Methods of solving transcendental equations: graphical method, bisection method, Regular Falsi method, Newton-Raphson method. **(Lectures: 20)**

Unit-IV: System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss-Seidel method. **(Lectures: 15)**

Books Recommended

1. 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).

2. K. Atkinson, *An Introduction to Numerical Analysis* (2nd Edition), Wiley Publications, (1978)

3. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, (2007).

4. S. S. Sastry, *Introductory Methods of Numerical Analysis*, Prentice hall of India, (2005).

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ABILITY ENHANCEMENT

COMPULSORY COURSES (AECC)

05/7/2021

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ENG-AE-111 Communicative English

Credit: L3:T1:P0 Lecture Hour: 40

Course Objective

The course aims to train learners to be more effective at communicating successfully in interviews, public speaking, letter writing, report writing, presentations, and inter-personal debates and conversations. The learner also imbibes the fundamentals of communication and the art of persuasive speaking and writing which depends crucially on clarity of thought and contextual understanding expressed through appropriate vocabulary.

Course Outcome

After completion of the course, learners will be able to master the art of persuasive speech and writing, the art of listening, reading, and analysing; spend the bulk of their time in class in practical exercises of reading and writing; develop critical thinking skills; and they will be introduced to established principles of academic reading and writing. Other specific outcomes:

- Identify deviant use of English both in written and spoken forms
- Recognize the errors of usage and correct them and write simple sentences without committing errors of spelling and grammar
- Developing own competence in using the language
- Understand and appreciate English spoken by others
- Use language for speaking with confidence in an intelligible and acceptable manner
- Understand the importance of reading for life and develop an interest for reading
- Read independently unfamiliar texts with comprehension
- Understand the importance of writing in academic life and career.

Module 01: **Poetry:** William Shakespeare – All the World is a stage; William Wordsworth – I wondered lonely as a Cloud; Ralph Waldo Emerson – The Mountain and the Squirrel; Emily Dickinson – Success is Counted Sweetest; Robert Frost - Stopping by Woods on a Snowy Evening; Rabindranath Tagore – Where the Mind is without Fear; A. K. Meherotra – Songs of the Ganga.

Module 02: **Short Stories:** R.K. Narayan – Lawly Road; Mulk Raj Anand – Barbar's Trade Union; Somerset Mangham – The Luncheon; Guy De. Maupassant – The Necklace; Anton Chekhov – The Lament; O' Henry – The Last Leaf; Manoj Das – The Submerged Valley.

Module 03: **One-Act Plays and Short Fiction:** (a) Norman Mckinnell - The Bishop's Candle Sticks; Anton Chekov – A Marriage Proposal; Eugene Lonesco – The Lesson; August Strandberg – Miss Jullie; Fritz Karinthy– Refund; (b) Harper Lee – To kill a Mocking Bird, (Or) R. K. Narayan – Vendor of Sweets.

Module 04: **Fundamentals of Grammar**: Parts of speech, Articles and Intensifiers, use of tense forms, Use of Infinitives, Conditionals, Adjectives and Adverbs, Prepositions, Making Affirmative, Negative and Interrogative, Making Question Tag.

Module 05: **Composition Practice:** (a) Comprehension, Précis Writing, Paragraph Writing (150 words), Letter writing – Personal, Official, Demi-official, Business, Public speaking, Soft Skills, Interviews, Preparing Curriculum Vitae, Report (Meetings and Academic) writing; (b) Communication Practice – Introducing yourself, Introducing people to others, Meeting People, Exchanging Greetings, Taking Leave, Answering the Telephone, Asking Someone for Some Purpose, Taking and Leaving Messages, Call for help in emergency.

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Module	Weightage of Marks	Theory	Practical
Module 01	20%	✔	
Module 02	20%	✔	
Module 03	20%	✔	
Module 04	20%	✔	✔
Module 05	20%	✔	✔

Practical Exercises

The students are required to:

1. know dictionary and its types, mapping a dictionary to locate words, and multiple uses of dictionary/ies
2. know the uses of Thesaurus/Lexicon/Activator/Encyclopaedia
3. know Note making/taking
4. know information transfer exercises
5. know the usage library resources properly
6. know citing references or developing a bibliography
7. Edit a piece of self and peer writing, writing and revising the drafts and preparing the final draft
8. Understand and appreciate the principle of politeness in relation to the speaker/ listener, debating, ex-tempore speeches, and other discourses.

Suggested Readings

Crystal, David (1985) Rediscover Grammar with David Crystal. Longman.

Hewings, M. (1999) Advanced English Grammar. Cambridge University Press.

Bakshi, R. N. A course in English Grammar, Orient Longman

Krishnaswamy, N. Modern English – A Book of Grammar, Usage and Composition. MacMillan India Ltd.

Bailey, Stephen (2003). Academic Writing. London and New York, Routledge.

Grellet, F (1981). Developing Reading Skills: A Practical Guide to Reading Skills. New York, CUP

Hedge, T. (2005). Writing. London, OUP

Kumar, S and Pushp Lata (2015). Communication Skills. New Delhi, OUP

Lazar, G. (2010). Literature and Language Teaching. Cambridge, CUP

Nuttall, C (1996). Teaching Reading Skills in a Foreign Language. London, Macmillan

Raman, Meenakshi and Sangeeta Sharma (2011). Technical Communication: Principles and Practice. New Delhi, OUP

Note: Students are advised to use latest edition of text books. For reading the texts, available sources of texts and help of the Web source may be taken.

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HIN-AE-111 हिंदी शिक्षण (Hindi Sikshan)

क्रेडिट (Credit): L3:T1:P0 व्याख्यान घंटे (Lecture Hours): 40

(यह पत्र प्रथम सत्र में हिन्दी कौशलाधारित पाठ्यक्रम चुनने वाले सभी विद्यार्थियों के लिये हैं। यह पत्र चार इकाइयों में विभक्त है। प्रत्येक इकाई के लिये व्याख्यानों की संख्या निर्धारित हैं)

उद्देश्य: *सामाजिक, व्यवसायिक, कार्यालयी तथा शैक्षणिक परिप्रेक्ष्य में विद्यार्थियों के भाषा-कौशल में निखार लाना। विद्यार्थियों में प्रतिस्पर्धात्मक परीक्षाओं एवं साक्षात्कार हेतु आत्मविश्वास उत्पन्न करना। विद्यार्थियों में रचनात्मक कौशल विकसित करना। भाषा-ज्ञान के माध्यम से विद्यार्थियों को रोजगारोन्मुख शिक्षा प्रदान करना।*

इकाई 1: राष्ट्रीय एवं अन्तरराष्ट्रीय परिप्रेक्ष्य में हिन्दी का महत्त्व; मानक हिन्दी और बोलचाल की हिन्दी में अन्तर; स्वागत भाषण, भाषण, विषय प्रवर्तन तथा धन्यवाद ज्ञापन। व्याख्यान – 10

इकाई 2: आलेख रचना: सम्पादक के नाम पत्र, सम्पादकीय लेखन, स्तम्भ लेखन, पत्र पत्रिकाओं के लिये आलेख रचना-; आकाशवाणी एवं दूरदर्शन हेतु वार्ता, साक्षात्कार एवं परिचर्चा तैयार करने की विधियाँ। व्याख्यान – 10

इकाई 3: व्यावहारिक लेखन: कार्यालयी पत्राचार; प्रेस विज्ञप्ति; सूचना ; ज्ञापन; कार्यसूची; कार्यवृत्त; प्रतिवेदन; सम्पादन; संक्षेपण; आत्मविवरण तथा ईमेल लेखन-, फेसबुक, ब्लॉग और ट्वीटर लेखन। व्याख्यान – 10

इकाई 4: सृजनात्मक लेखन: कविता, कहानी, नाटक तथा एकांकी, निबंध, यात्रावृत का स्वरूप विवेचन। व्याख्यान – 10

उपलब्धियां -हिंदी शिक्षण से सम्बन्धित इस पत्र में विद्यार्थी हिन्दी भाषा के व्यावहारिक स्वरूप तथा प्रयोजनमूलक हिन्दी के क्षेत्र लेखन से जुड़ी बहुविध जानकारियों से परिचित हुए। हिन्दी भाषा की बढ़ती लोकप्रियता और बढ़ते अन्तरराष्ट्रीय महत्त्व के सन्दर्भ में हिन्दी भाषा आधारित कौशल विकास से विद्यार्थियों को अवगत कराया गया। विशेषकर आलेख रचना के अतिरिक्त व्यावहारिक एवं सर्जनात्मक लेखन से जुड़ी बारीकियों को जान सके।

कार्य सम्पादन पद्धति: व्याख्यान, विचारविमर्श-, समूहचर्चा-, सामग्री-समीक्षा और प्रस्तुतीकरण आदि।

Module	Weightage of Marks	Theory	Practical / Numerical
Module 01	25%	✔	✔
Module 02	25%	✔	✔
Module 03	25%	✔	✔
Module 04	25%	✔	

सहायक ग्रन्थ

1. अच्छी हिन्दी : रामचन्द्र वर्मा
2. व्यवहारिक हिन्दी व्याकरण और रचना : हरदेव बाहरी
3. हिन्दी भाषा : डॉ भोलानाथ तिवारी
4. रेडियों लेखन : मधुकर गंगाधर
5. टेलीविजनः सिद्धान्त और टैकनिक : मथुरादत्त शर्मा
6. प्रयोजनमूलक हिन्दी : डॉ दंगल झाल्टे
7. सरकारी कार्यालयों में हिन्दी का प्रयोग : गोपीनाथ श्रीवास्तव, राजकमल, दिल्ली
8. टेलीविजन लेखन : असगर वजाहत / प्रेमरंजन; राजकमल, दिल्ली
9. रेडियो नाटक की कला : डॉ सिद्धनाथ कुमार, राजकमल, दिल्ली
10. रेडियो वार्ता शिल्प : सिद्धनाथ कुमार, राजकमल, दिल्ली

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EVS-AE-121: ENVIRONMENTAL STUDIES

Credits: L4:T0:P0 = 4 Credits

Course Objective

The objective of this paper is to provide basic concept of on Environment, Ecology, Natural Resources, Importance of biodiversity and need for their conservation along with various environmental issues and Govt. policies, and Environmental movements.

Learning outcomes

- Learners will be able to understand environment science and its importance.
- Learners will understand the various types of pollution and hazards caused by them.
- Learners will understand ways to monitor environment and the various green technologies.
- Learners will know the various Acts enacted for the protection of the environment.

Key Words: Environment, Ecosystem, Natural Resources, Biodiversity, Environmental Issues and Policies

Unit I: Basic Concept of Environment **12 Lectures**

Environment: Definition, scope and importance; Multidisciplinary nature of environmental studies. Concept of sustainability and sustainable development.
Ecosystem – Concept, Structure and function; Energy flow in an ecosystem: food chains, food webs, ecological pyramid. Ecological succession. Ecosystem services.

Unit II: Natural Resources **12 Lectures**

Land as a resource, Land use patterns, land degradation, soil erosion and desertification.
Forest Resources, Use and over-exploitation; Deforestation - causes and impacts on environment.
Water Resources, Use and over-exploitation of surface and ground water; floods, droughts, Case studies on conflicts over water (international & inter-state).
Energy Resources, Renewable and non-renewable energy sources, growing energy needs, use of alternate energy sources.
Traditional ecological knowledge.

Unit III: Biodiversity and Conservation **12 Lectures**

Biodiversity: Definition, levels (genetic, species and ecosystem diversity) and values; Biogeographic zones of India; Biodiversity hot spots. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions.
Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.
Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Issues and Policies **24 Lectures**

Environmental pollution: types, causes, effects and controls of Air, water, soil, noise, solid waste and nuclear pollution.
Global environmental issues: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
Salient features of Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Paris agreement, Nagoya Protocol.
Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare.
Disaster management: Floods, Earthquake, Cyclones and Landslides.
Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

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Suggested readings

Bharucha, E. 2020. Textbook for Environmental Science for undergraduate students. University Grants Commission, New Delhi.

Gupta Abhik and Gupta Susmita. 2021. Environmental Studies: Principles and Practices. 344 pages, SAGE Texts.

Ahluwalia, V.K.. Environmental Studies. 2nd Ed. TERI Press.

Kaushik Anubha and Kaushik, C.P. 2018. Perspectives in Environmental Studies. 6th Ed. New Age International Pvt. Ltd.

Krishnamurthy, K. V. 2020.An advanced textbook on Biodiversity: Principles and Practice. CBS Publisher and Distributors

Ambasht, R. S. and Ambasht, P.K. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors.

Ambasht, R. S. and Ambasht, N.K. 2017. A textbook of Plant Ecology. 15th Ed. CBS Publishers and Distributors, New Delhi.

Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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