SEMESTER-I

Paper-BMTMCCHT101

Title: Calculus & Analytical Geometry (2D)

Syllabus:

Unit -1: Differential Calculus [Credit-2]

Higher order derivatives, Leibnitz rule of successive differentiation and its applications. Indeterminate forms, L'Hospital's rule.

Basic ideas of Partial derivative, Chain Rules, Jacobian, Euler's theorem and its converse.

Tangents and Normals, Sub-tangent and sub-normals, Derivatives of arc lengths, Pedal equation of a curve.

Concavity and inflection points, curvature and radius of curvature, envelopes, asymptotes, curve tracing in Cartesian and polar coordinates of standard curves.

Unit-2: Integral Calculus [Credit-1]

Reduction formulae, derivations and illustrations of reduction formulae, rectification & quadrature of plane curves, area and volume of surface of revolution.

Unit -3: Two-Dimensional Geometry [Credit-2]

Transformation of Rectangular axes: Translation, Rotation and Rigid body motion, Theory of Invariants.

Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Point of intersection, Angle between pair of lines, Angle bisector, Equation of two lines joining the origin to the points in which a line meets a conic.

General Equation of second degree in two variables: Reduction into canonical form.

Tangents, Normals, chord of contact, poles and polars, conjugate points and conjugate lines of Conics.

Polar Co-ordinates, Polar equation of straight lines, Circles, conics. Equations of tangents, normals Chord of contact of Circles and Conics.

Graphical Demonstration (Teaching Aid)

1. *Plotting of graphs of function eax + b, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.*

2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).

4. Obtaining surface of revolution of curves.

5. Tracing of conics in Cartesian coordinates/polar coordinates.

Reading References:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
5. T. Apostol, Calculus, Volumes I and II.
6. S. Goldberg, Calculus and Mathematical Analysis.
7. S.C. Malik and S. Arora, Mathematical Analysis.
8. Shantinarayan, Mathematical analysis.
9. J.G. Chakraborty&P.R.Ghosh, Advanced Analytical Geometry.
10. S.L. Loney, Coordinate Geometry.
11. R. M. Khan, Introduction to Geometry

Paper-BMTMCCHT102

Title: Algebra-I

Syllabus:

Unit -1: Classical Algebra [Credit-3]

Complex Numbers: De-Moivre's Theorem and its applications, Direct and inverse circular and hyperbolic functions, Exponential, Sine, Cosine and Logarithm of a complex number, Definition of (a≠0), Gregory's Series.

Simple Continued fraction and its convergent, representation of real numbers.

Polynomial equation, Fundamental theorem of Algebra (Statement only), Multiple roots, Statement of Rolle's theorem only and its applications, Equation with real coefficients, Complex roots, Descarte's rule of sign, relation between roots and coefficients, transformation of equation, reciprocal equation, binomial equation– special roots of unity, solution of cubic equations–Cardan's method, solution of biquadratic equation– Ferrari's method.

Inequalities involving arithmetic, geometric and harmonic means and their generalizations, Schwarz and Weierstrass'sinequalities.

Unit -2: Abstract Algebra & Number Theory [Credit-2]

Mappings, surjective, injective and bijective, Composition of two mappings, Inversion of mapping.Extension and restriction of a mapping ; Equivalence relation and partition of a set, partially ordered relation. Hesse's diagram, Lattices as partially ordered set, definition of lattice in terms of meet and join, equivalence of two definitions, linear order relation;

Principles of Mathematical Induction, Primes and composite numbers, Fundamental theorem of arithmetic, greatest common divisor, relatively prime numbers, Euclid's algorithm, least common multiple.

Congruences: properties and algebra of congruences, power of congruence, Fermat's congruence, Fermat's theorem, Wilson's theorem, Euler – Fermat's theorem, Chinese remainder theorem, Number of divisors of a number and their sum, least number with given number of divisors.

Eulers φ function-$\varphi(n)$. Mobius μ-function, relation between φ function and μ function. Diophantine equations of the form $ax+by = c$, a, b, c integers.

Reading References:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. W.S. Burnstine and A.W. Panton, Theory of equations.
4. S.K. Mapa, Higher Algebra (Classical).
5. S.K. Mapa, Higher Algebra (Linear and Abstract).
6. T.M. Apostol, Number Theory
7. Juckerman, Number Theory
8. A.K. Chowdhury, Number Theory

SEMESTER-II

Paper-BMTMCCHT201

Title: Real Analysis-I

Syllabus:

Review of Algebraic and Order Properties of R, ε-neighbourhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets. Suprema and Infima.Completeness Property of R and its equivalent properties. The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, open set, closed set, derived set, Illustrations of Bolzano-Weierstrass theorem for sets.

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, liminf, lim sup. Limit Theorems. Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria. Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Raabe's test, Gauss's test (proof not required), Cauchy's condensation test (proof not required), Integral test. Alternating series, Leibniz test. Absolute and Conditional convergence.

Graphical Demonstration (Teaching Aid)

1.*Plotting of recursive sequences.*

2. Study the convergence of sequences through plotting.

3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.

4. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

5. Cauchy's root test by plotting nth roots.

6. Ratio test by plotting the ratio of nth and (n+1)th term.

Reading References:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
5. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
6. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
7. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
8. Terence Tao, Analysis I, Hindustan Book Agency, 2006
9. S. Goldberg, Calculus and mathematical analysis.
10. S.K.Mapa, Real analysis.
11. Malik & Arora, Real Analysis
12. Shantinarayan, Real Analysis

Paper-BMTMCCHT202

Title: Ordinary Differential Equations and Linear Algebra

Syllabus:

Unit -1: Differential Equation [Credit-3]

Prerequisite *[Genesis of differential equation: Order, degree and solution of an ordinary differential equation, Formation of ODE, Meaning of the solution of ordinary differential equation, Concept of linear and non-linear differential equations]*.

Picard's existence and uniqueness theorem (statement only) for $dydx=f(x,y)$ with $y = y0$ at $x = x0$ and its applications.

Solution of first order and first degree differential equations:

Homogeneous equations and equations reducible to homogeneous forms, Exact differential equations, condition of exactness, Integrating Factor, Rules of finding integrating factor (statement of relevant results only), equations reducible to exact forms, Linear Differential Equations, equations reducible to linear forms, Bernoulli's equations. Solution by the method of variation of parameters.

Differential Equations of first order but not of first degree: Equations solvable for $p=dydx$, equations solvable for y, equation solvable for x, singular solutions, Clairaut's form, equations reducible to Clairaut's Forms- General and Singular solutions.

Applications of first order differential equations: Geometric applications, Orthogonal Trajectories.

Linear differential equation of second and higher order. Linearly dependent and independent solutions, Wronskian, General solution of second order linear differential equation, General and particular solution of linear differential equation of second order with constant coefficients. Particular integrals for polynomial, sine, cosine, exponential function and for function as combination of them or involving them, Method of variation of parameters for P.I. of linear differential equation of second order

Linear Differential Equations With variable co-efficients: Euler- Cauchy equations, Exact differential equations, Reduction of order of linear differential equation. Reduction to normal form.

Simultaneous linear ordinary differential equation in two dependent variables. Solution of simultaneous equations of the form $dx/P = dy/Q = dz/R$. Pfaffian Differential Equation $Pdx + Qdy + Rdz = 0$, Necessary and sufficient condition for existence of integrals of the above (proof not required), Total differential equation.

Unit -2: Linear Algebra [Credit-2]

Vector space, subspaces, Linear Sum, linear span, linearly dependent and independent vectors, basis, dimensions of a finite dimensional vector space, Replacement Theorem, Extension theorem, Deletion theorem, change of coordinates, Row space and column space, Row rank and column rank of a matrix.

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $Ax=b$, Existence of solutions of homogeneous system of equations and determination of their solutions, solution sets of linear systems, applications of linear systems, linear independence.

Reading References:

1. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
2. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
3. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
4. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
5. G.F.Simmons, Differential Equations, Tata McGraw Hill
6. G. C. Garain, Introductory course on Differential Equations

SEMESTER-III

Paper-BMTMCCHT301

Title: Real Analysis-II

Syllabus:

Unit-1: Calculus of Single Variable [Credit-3]

Limits of functions (ε-δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions. Application of Taylor's theorem to inequalities.

Unit- 2: Multivariable Calculus [Credit-2]

Functions of several variables, limit and continuity of functions of two or more variables

Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Directional derivatives, the gradient, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

Reading References:

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons.
2. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House
3. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill

4. S. Goldberg, Calculus and Mathematical Analysis.
5. Santinarayan, Integral Calculus.

Paper-BMTMCCHT302

Title: Algebra-II

Syllabus:

Group: Uniqueness of identity and inverse element, law of cancellation, order of a group and order of an element, Abelian Group, sub-group – Necessary and sufficient condition, Finite Group. Simple examples.

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Definition and examples of Rings, properties of Rings, Subrings, Integral Domains, Characteristic of a Ring.

Definition and examples Field, Subfield, Finite Field, characteristics of a Field.

Reading References:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
6. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
7. Sen, Ghosh, Mukhopadhaya, Abstract Algebra.
8. S. K. Mapa, Abstract Algebra

Paper-BMTMCCHT303

Title: Geometry-3D & Vector Analysis

Syllabus:

Unit-1: Three-Dimensional Geometry [Credit-3]

Plane; Straight lines

Sphere: General Equation, Circle, Sphere through circle, Tangent, Normal.

Cone: General homogeneous second degree equation, Enveloping cone, Section of cone by a plane, Tangent and normal, Condition for three perpendicular generators, Reciprocal cone, Right circular cone, Cylinder, Enveloping cylinder, Right circular Cylinder.

Conicoids: Ellipsoid, Hyperboloid, Paraboloid: Canonical equations only. Plane sections of it.

Ruled surface, Generating lines of hyperboloid of one sheet and hyperbolic paraboloid, their properties.

Transformation of Co-ordinates, Invariants, Reduction of general equation of three variables.

Knowledge of Cylindrical and Spherical polar co-ordinates.

Unit -2: Vector Analysis [Credit-2]

Product of three or more vectors,

Vector Calculus: Continuity and differentiability of vector-valued function of one variable, Space curve, Arc length, Tangent, Normal. Serret- Frenet's formulae. Integration of vector-valued function of one variable.

Vector-valued functions of two and three variables, Gradient of scalar function, Gradient vector as normal to a surface, Divergence and Curl, their properties.

Evaluation of line integral of the type

Evaluation of surface integrals of the type

Evaluation of volume integrals of the type

Green's theorem in the plane. Gauss and Stokes' theorems (Proof not required), Green's first and second identities.

Reading References:

1. M.R. Speigel, Schaum's outline of Vector Analysis
2. Marsden, J. and Tromba, Vector Calculus, McGraw Hill.
3. Maity, K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
4. Shantinarayan and P K Mittal, Vector Analysis
5. J. T. Bell, Vector Analysis
6. Ghosh and Chakraborty, Geometry
7. Ghosh and Chakraborty, Vector Analysis
8. R. M. Khan, Geometry

Paper-BMTMSEHT305

Title: Logic and Sets

Syllabus:

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.

Sets, subsets, Set operations and 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. Partial ordering relations, n- arry relations.

Reading References:

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. Santha, Discrete Mathematics (Cengage Learning).

SEMESTER-IV

Paper-BMTMCCHT401

Title: Dynamics of Particle

Syllabus:

Kinematics

1. Expressions for velocity & acceleration for

(i) Motion in a straight line;

(ii) Motion in a plane;

(a) Cartesian co-ordinates, (b) polar co-ordinates, (c) tangential and normal direction, (d) referred to rotating axes in the plane.

(iii) Motion in three dimension in rectangular Cartesian co-ordinates.

Kinetics

2. Basic kinematic quantities: Momentum and Angular momentum of a moving particle, Potential energy and Kinetic energy of a particle, Principles of conservation (i) of linear momentum, (ii) of angular momentum, (iii) of energy of a particle, Work and Power and simple examples on their applications.

3. Newton's laws of motion, Equation of motion of a particle moving under the action of given external forces.

(a) Motion of a particle in a straight line under the action of forces $\mu x n$, $n = 0, \pm 1, n = -2$ ($\mu > 0$ or < 0) with physical interpretation,

(b) simple harmonic motion and elementary problems,

(c) the S.H.M. of a particle attached to one end of an elastic string, the other end being fixed,

(d) harmonic oscillator, effect of a disturbing force, linearly damped harmonic motion and Forced oscillation with or without damping,

(f) Vertical motion under gravity when resistance varies as some integral power of velocity, terminal velocity.

4. Impulse of force, Impulsive forces, change of momentum under impulsive forces, Examples, Collision of two smooth elastic bodies, Newton's experimental law of impact, Direct and oblique impacts of (i) Sphere on a fixed horizontal plane, (ii) Two smooth spheres, Energy loss.

5. Motion in two dimensions:

(a) Velocity and acceleration of a particle moving on a plane in Cartesian and polar coordinates, Motion of a particle moving on a plane referred to a set of rotating rectangular axes, Angular velocity and acceleration, Circular motion, Tangential and normal accelerations.

(b) Trajectories in a medium with the

(i) Motion of a projectile under gravity with air resistance neglected;

(ii) Motion of a projectile under gravity with air resistance proportional to velocity, square of the velocity;

(iii) Motion of a simple pendulum;

(c) Central forces and central Orbits: Motion under a central force, basic properties and differential equation of the path under given forces and velocity of projection, Apses, Time to describe a given arc of an orbit, Law of force when the center of force and the central orbit are known. Special study of the following problems:

To find the central force for the following orbits –

(i) A central conic with the force directed towards the focus;

(ii) Equiangular spiral under a force to the pole;

(iii) Circular orbit under a force towards a point on the circumference.

To determine the nature of the orbit and of motion for different velocity of projection under a force per unit mass equal to –

(i) μ / (dist)2 towards a fixed point ;

(ii) under a repulsive force μ / (dist)2 away from a fixed point .

(d) Circular orbit under any law of force μ f (r) with the centre of the circle as the centre of force, Question of stability of a circular orbit under a force μ f (r) towards the center. Particular case of μ f (r) =1/rn.

(e) Kepler's laws of planetary motion from the equation of motion of a central orbit under inverse square law, Modification of Kepler's third law from consideration of motion of a system of two particles under mutual attractions according to Newton's law of gravitational attraction, Escape velocity.

(f) Constrained Motion: Motion of a particle along a smooth curve, Examples of motion under gravity along a smooth vertical circular curve.

Reading References:

1. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press
2. Terence Tao, Analysis II, Hindustan Book Agency, 2006
3. Ganguly and Saha, Dynamics of Particle
4. Dutta and Jana, Dynamics of a Particle
5. Ramsey, Dynamics of a Particle

Paper-BMTMCCHT402

Title: Partial Differential Equation, Laplace Transform & Tensor Analysis

Syllabus:

Unit-1: Partial Differential Equation [Credit-2]

Partial Differential Equations – Basic concepts and Definitions. Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First- order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Solution by Lagrange's and Charpit's method.

Unit-2: Laplace Transform [Credit-1]

Definition and properties of Laplace transforms, Sufficient conditions for the existence of Laplace Transform, Laplace Transform of some elementary functions, Laplace Transforms of the derivatives, Initial and final value theorems, Convolution theorems, Inverse of Laplace Transform, Application to Ordinary differential equations

Unit-3: Tensor Analysis [Credit-2]

Tensor as a generalized concept of a vector in E3.Generalization of idea to an n-dimensional Euclidean space (En), Definition of an n-dimensional space, Transformation of Co-ordinates.

Summation Convention, Kronecker delta, Invariant, Contravariant and Covariant vectors, Contravariant and Covariant tensors, Mixed tensors. Algebra of tensors, Symmetric and Skew- symmetric tensors, Contraction, Outer and inner products of tensors, Quotient Law (Statement only).

Fundamental metric tensor of Riemannian space, Reciprocal metric tensor. A magnitude of a vector, angle between two vectors, Christoffel symbols, Covariant differentiation of vectors and tensors of rank 1 and 2. The identities gij,k= gij, k = 0 and δ ij , k = 0.

Reading References:

1. Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
2. Miller, F. H., Partial Differential Equations, John Wiley and Sons
3. Sneddon, I.N., Use of Integral Transforms, McGraw-Hill Pub.
4. Andrews, L.C., Shivamoggi, B., Integral Transforms for Engineers, PHI.
5. M. C. Chaki, Tensor Analysis
6. B. Spain, Tensor Calculus: A Concise Course, Dover Publication, 2003.
7. U.C. De, Tensor Calculus
8. M. Majumder, A. Bhattacharyya, Differential Geometry, Books & Allied Pub.
9. Sokolnikoff, Tensor Analysis.

Paper-BMTMCCHT403

Title: Real Analysis-III

Syllabus:

Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two Definitions.

Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.

Intermediate Value theorem for Integrals.Fundamental theorem of Integral Calculus.

Improper integrals. Convergence of Beta and Gamma functions.

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions.

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

Fourier series: Definition of Fourier coefficients and series, ReimannLebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition.

Examples of Fourier expansions and summation results for series.

Power series, radius of convergence.

Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Reading References:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
5. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill

Paper-BMTMSEHT405

Title: Graph Theory

Syllabus:

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs.

Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems

Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

Reading References:

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

SEMESTER-V

Paper-BMTMCCHT501

Title: Algebra-III

Syllabus:

Unit-1: Abstract Algebra [Credit-2]

External direct product of a finite number of groups, normal subgroups, quotient groups, Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms.First, Second and Third isomorphism theorems, Automorphism.

Ideal, ideal generated by a subset of a ring, quotient rings, operations on ideals, prime, maximal and primary ideals, quotient ring.

Ring homomorphism, isomorphism, 1st, 2nd and 3rd isomorphism theorems, Every integral domain can be extended to a field.

Unit-2: Linear Algebra [Credit-3]

Introduction to linear transformations, algebra of linear transformation.null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation. Inverse of a matrix, characterizations of invertible matrices. Subspaces of Rn, dimension of subspaces of Rn, rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Characteristic equation, statement of Caley-Hamilton theorem and its application, eigen values, eigen vectors, similar matrices, diagonalization of matrices of order 2 and 3, Real Quadratic Form involving three variables, Reduction to Normal Form (Statements of relevant theorems and applications).

Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator.

Reading References:

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

6. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
7. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
8. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
9. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
10. S. K. Mapa, Abstract and Linear Algebra.
11. M K Sen, S Ghosh, P Mukhopadhyay, Topics in Abstract Algebra, U. Press.

Paper-BMTMCCHT502

Title: Metric Spaces & Complex Analysis

Syllabus:

Unit-1: Metric Spaces [Credit-3]

Metric, examples of standard metric spaces including Euclidean and Discrete metrics; open ball, closed ball, open sets; metric topology; closed sets, limit points and their fundamental properties; interior, closure and boundary of subsets and their interrelation; denseness; separable and second countable metric spaces and their relationship.

Continuity: Definition of continuous functions, algebra of real/complex valued continuous functions, distance between a point and a subset, distance between two subsets, Homeomorphism (definitions with simple examples)

Connectedness: Connected subsets of the real line R, open connected subsets in R2, components; components of open sets in R and R2; Structure of open set in R, continuity and connectedness; Intermediate value theorem.

Sequence and completeness: Sequence, subsequence and their convergence; Cauchy sequence, Cauchy's General Principle of convergence, Cauchy's Limit Theorems. completeness, completeness of Rn; Cantor's theorem concerning completeness, Definition of completion of a metric space, construction of the real as the completion of the incomplete metric space of the rational with usual distance (proof not required). Continuity preserves convergence. Compactness.

Unit-2: Complex Analysis [Credit-2]

Introduction of complex number as ordered pair of real numbers, geometric interpretation, metric structure of the complex plane **C**, regions in **C.** Stereographic projection and extended complex plane **C**∞ and circles in **C**∞ .

Limit, Continuity and differentiability of a complex function, sufficient condition for differentiability of a complex function, Analytic functions and Cauchy-Riemann equation, harmonic functions, Conjugate harmonic functions, Relation between analytic function and harmonic function.

Power series, radius of convergence, sum function and its analytic behavoiur within the circle of convergence, Cauchy-Hadamard theorem.

Transformation (mapping), Concept of Conformal mapping, Bilinear (Mobius) transformation and its geometrical meaning, fixed points and circle preserving character of Mobius transformation.

Reading References:

1. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
3. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
4. S. Ponnusamy, Foundations of complex analysis.

Paper-BMTMDSHT1

Title: Linear Programming

Syllabus:

General introduction to optimization problem, Definition of L.P.P., Mathematical formulation of the problem, Canonical & Standard form of L.P.P.

Basic solutions, feasible, basic feasible & optimal solutions, Reduction of a feasible solution to basic feasible solution.

Hyperplanes and Hyperspheres, Convex sets and their properties, convex functions, Extreme points, Convex feasible region, Convex polyhedron, Polytope, Graphical solution of L. P.P.

Fundamental theorems of L.P.P., Replacement of a basis vector, Improved basic feasible solutions, Unbounded solution, Condition of optimality, Simplex method, Simplex algorithm, Artificial variable technique (Big M method, Two phase method), Inversion of a matrix by Simplex method. Degeneracy in L.P.P. and itsresolution.

Duality in L.P.P.: Concept of duality, Fundamental properties of duality, Fundamental theorem of duality, Duality & Simplex method, Dual simplex method and algorithm.

Transportation Problem (T.P.): Matrix form of T.P., the transportation table, Initial basic feasible solutions (different methods like North West corner, Row minima, Column minima, Matrix minima & Vogel's Approximation method), Loops in T.P. table and their properties, Optimal solutions, Degeneracy in T.P., Unbalanced T.P.

Assignment Problem, Mathematical justification for optimal criterion, optimal solution by Hungarian Method, Travelling Salesman Problem.

Theory of Games : Introduction, Two person zero-sum games, Minimax and Maximinprinciples, Minimax and Saddle point theorems, Mixed Strategies games without saddle points, Minimax (Maximin) criterion, The rules of Dominance, Solution methods of games without Saddle point; Algebraic method, Matrix method, Graphical method and Linear Programming method.

Reading References:

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

Paper-BMTMDSHT2

Title: Mechanics-I

Syllabus:

Foundations of Classical Dynamics

Inertial frames, Newton's laws of motion, Galilean transformation, Form-invariance of Newton's laws of motion under Galilean transformation, Fundamental forces in classical physics (gravitation), Electric and Magnetic forces, action-at-a-distance. Body forces; contact forces: Friction, Viscosity.

System of particles

Fundamental concepts, centre of mass, momentum, angular momentum, kinetic energy, work done by a field of force, conservative system of forces – potential and potential energy, internal potential energy, total energy.

The following important results to be deduced in connection with the motion of system of particles:

(i) Centre of mass moves as if the total external force were acting on the entire mass of the system concentrated at the centre of mass (examples of exploding shell, jet and rocket propulsion).

(ii) The total angular momentum of the system about a point is the angular momentum of the system concentrated at the centre of mass, plus the angular momentum for motion about the center.

(iii) Similar theorem as in (ii) for kinetic energy.

Conservation laws: conservation of linear momentum, angular momentum and total energy for conservative system of forces.

An idea of constraints that may limit the motion of the system, definition of rigid bodies, D'Alembert's principle, principle of virtual work for equilibrium of a connected system.

Rigid Body

Moments and products of inertia (in three-dimensional rectangular co-ordinates), Inertia matrix, Principal values and principal axes of inertia matrix. Principal moments and principal axes of inertia for (i) a rod, (ii) a rectangular plate, (iii) a circular plate, (iv) an elliptic plate, (v) a sphere, (vi) a right circular cone, (vii) a rectangular parallelepiped and (viii) a circular cylinder.

Equation of motion of a rigid body about a fixed axis, Expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis, Compound pendulum, Interchangeability of the points of a suspension and centre of oscillation, Minimum time of oscillation.

Equations of motion of a rigid body moving in two-dimension, Expression for kinetic energy and angular momentum about the origin of rigid body moving in two dimensions. Necessary and sufficient condition for pure rolling, Two-dimensional motion of a solid of revolution moving on a rough horizontal plane, the following examples of the two-dimensional motion of a rigid body to be studied:

(i) Motion of a uniform heavy sphere (solid and hollow) along a perfectly rough inclined plane;

(ii) Motion of a uniform heavy circular cylinder (solid and hollow) along a perfectly rough inclined plane:

(iii) Motion of a rod when released from a vertical position with one end resting upon a perfectly rough table or smooth table.

(iv) Motion of a uniform heavy solid sphere along an imperfectly rough inclined plane;

(v) Motion of a uniform circular disc, projected with its plane vertical along an imperfectly rough horizontal plane with a velocity of translation and angular velocity about the centre.

Reading References:

1. Chorlton, F., Textbook of Dynamics.
2. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies
3. Loney, S. L., Elements of Statics and Dynamics I and II.
4. Ramsey, A. S., Dynamics (Part I).

Paper-BMTMDSHT3

Title: Theory of Equations

Syllabus:

Unit 1:
General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

Unit 2:
Symmetric functions. Applications of symmetric function of the roots. Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

Unit 3:
Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

Unit 4:
Separation of the roots of equations, Strums theorem. Applications of Strum's theorem, Conditions for reality of the roots of an equation. Solution of numerical equations.

Reading References:

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.

SEMESTER-VI

Paper-BMTMCCHT601

Title: Numerical Methods & Computer Programming

Syllabus:

Unit-1: Numerical Methods [Credit-3]

Algorithms.Convergence. Errors: Relative, Absolute. Round off. Truncation.

Transcendental and Polynomial equations: Bisection method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Geometrical interpretation, convergency conditions, Rate of convergence of these methods.

System of linear algebraic equations: Gaussian Elimination, Gauss Seidel method and their convergence analysis.

Interpolation: Lagrange and Newton's methods. Error bounds.Finite difference operators.

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Composite Trapezoidal rule, Composite Simpson's 1/3rd rule.

Ordinary Differential Equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Unit-2: Computer Programming [Credit-2]

Introduction to computer

Computer Languages:Machine language, Assembly language, computer-high level languages, Compiler, Interpreter, Operating system, Source programs and objects programs.

Boolean algebra and its application to simple switching circuits.

Binary number system, Conversions and arithmetic operation, Representation for Integers and Real numbers, Fixed and floating point.

Introduction to C programming: Basic structures, Character set, Keywords, Identifiers, Constants, Variable-type declaration

Operators: Arithmetic, Relational, Logical, assignment, Increment, decrement, Conditional. Operator precedence and associativity, Arithmetic expression,

Statement: Input and Output, Define, Assignment, User define, Decision making (branching and looping) – Simple and nested IF, IF – ELSE, LADDER, SWITCH, GOTO, DO, WHILE – DO, FOR, BREAK AND CONTINUE Statements. Arrays- one and two dimensions, user defined functions.

Statistical and other simple programming

(a) To find mean, median, mode, standard deviation

(b) Ascending, descending ordering of numbers

(c) Finite sum of a series

(d) Fibonacci numbers

(e) Checking of prime numbers

(f) Factorial of a number

(g) Addition and multiplication of two matrices

(h) Matrix Inversion

Reading References:

1. S.A. Mollah, Numerical Analysis and Computational Procedures.
2. Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
3. Yashavant Kanetkar, Let Us C , BPB Publications.
4. Xavier, C., C Language and Numerical Methods, (New Age Intl (P) Ltd. Pub.)
5. Gottfried, B. S., Programming with C (TMH).
6. Balaguruswamy, E., Programming in ANSI C (TMH).
7. N. Datta- Computer Programming and Numerical Analysis-An Integrated Approach (Revised edition with C)-(Universities Press)

Paper-BMTMCCHT602

Title: Computer Aided Numerical Practical (P)

Syllabus:

List of Problems for C Programming

1. Finding a real Root of an equation by

(a) Fixed point iteration and **(b)** Newton-Rapson's method.

2. Interpolation (Taking at least six points) by

(a) Lagrange's formula and **(b)** Newton's Forward & Backward Difference Formula.

3. Integration by

(a) Trapezoidal rule

(b) Simpson's 1/3rdrule (taking at least 10 sub-intervals)

4. Solution of a 1storder ordinary differential equation by

(a) Modified Euler's Method

(b) Fourth-order R. K. Method, taking at least four steps.

Reading References:

1. Yashavant Kanetkar, Let Us C , BPB Publications.
2. Xavier, C., C Language and Numerical Methods, (New Age Intl (P) Ltd. Pub.)
3. Gottfried, B. S., Programming with C (TMH).
4. Balaguruswamy, E., Programming in ANSI C (TMH).
5. Scheid, F., Computers and Programming (Schaum's series)
6. Jeyapoovan, T., A first course in Programming with C.

Paper-BMTMDSHT4

Title: Probability and Statistics

Syllabus:

Unit-1: Probability [Credit-3]

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.Central Limit theorem for independent and identically distributed random variables with finite variance.

Unit-2: Statistics [Credit-2]

Moments and measures of Skewness and Kurtosis.

Bivariate frequency distribution, Scatter diagram, Correlation co-efficients, regression lines and their properties.

Concept of statistical population and random sample, Sampling distribution of sample mean and related $\chi 2$ and t distribution.

Estimation – Unbiasedness and minimum variance, consistency and efficiency, method of maximum likelihood, interval estimation for mean or variance of normal populations.

Testing of hypothesis (based on z, t and $\chi 2$ distributions).

Reading References:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. G Shanker Rao, Probability and Statistics, Universities Press.

Paper-BMTMDSHT5

Title: Mechanics-II

Syllabus:

Unit-1: Statics [Credit- 2]

Forces in three dimensions: Forces, concurrent forces, Parallel forces, Moment of a force, Couple, Resultant of a force and a couple (Fundamental concept only), Reduction of forces in three-dimensions, Pointsot's central axis, conditions of equilibrium.

Virtual work: Principle of Virtual work, Deduction of the conditions of equilibrium of a particle under coplanar forces from the principle of virtual work, Simple examples of finding tension or thrust in a two-dimensional structure in equilibrium by the principle of virtual work.

Stable and unstable equilibrium, Coordinates of a body and of a system of bodies, Field of forces, Conservative field, Potential energy of a system, Dirichlet's Energy test of stability, stability of a heavy body resting on a fixed body with smooth surfaces- simple examples.

General equations of equilibrium of a uniform heavy inextensible string under the action of given coplanar forces, common catenary, catenary of uniform strength.

Unit-2: Elements of Continuum Mechanics & Hydrostatics [Credit- 3]

Deformable body, Idea of a continuum (continuous medium), Surface forces or contact forces, Stress at point in a continuous medium, stress vector, components of stress (normal stress and shear stress) in rectangular Cartesian co-ordinate system; stress matrix, Definition of ideal fluid and viscous fluid.

Pressure (pressure at a point in a fluid in equilibrium is same in every direction), Incompressible and compressible fluid, Homogeneous and non-homogeneous fluids.

Equilibrium of fluids in a given field of force; pressure gradient, Equipressure surfaces, equilibrium of a mass of liquid rotating uniformly like a rigid body about an axis, Simple applications.

Pressure in a heavy homogeneous liquid. Thrust on plane surfaces, center of pressure, effect of increasing the depth without rotation, Centre of pressure of a triangular & rectangular area and of a circular area immersed in any manner in a heavy homogeneous liquid, Simple problems.

Thrust on curved surfaces: Archemedes' principle, Equilibrium of freely floating bodies under constraints. (Consideration of stability not required).

Equation of state of a 'perfect gas', Isothermal and adiabatic processes in an isothermal atmosphere, Pressure and temperature in atmosphere in convective equilibrium.

Reading References:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
2. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies
3. Loney, S. L., Elements of Statics and Dynamics I and II.
4. Ghosh, M. C, Analytical Statics.
5. Ramsey, A. S., Dynamics (Part I).

Paper-BMTMDSHT6

Title: Point Set Topology

Syllabus:

Unit 1:
Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantor's Theorem. Cardinal Numbers and Cardinal Arithmetic. Continuum Hypothesis, Zorns Lemma, Axiom of Choice.
Well-Ordered Sets, Hausdorff's Maximal Principle. Ordinal Numbers.

Unit 2:
Topological spaces, Basis and Subbasis for a topology, subspace Topology, Interior Points, Limit Points, Derived Set, Boundary of a set, Closed Sets, Closure and Interior of a set. Continuous Functions, Open maps, Closed maps and Homeomorphisms. Product Topology, Quotient Topology, Metric Topology, Baire Category Theorem. Unit 3 Connected and Path Connected Spaces, Connected Sets in R, Components and Path Components, Local Connectedness. Compact Spaces, Compact Sets in R. Compactness in Metric Spaces. Totally Bounded Spaces, Ascoli-Arzela Theorem, The Lebesgue Number Lemma. Local Compactness.

Reading References:

1. Munkres, J.R., Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. Dugundji, J., Topology, Allyn and Bacon, 1966.
3. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
4. Kelley, J.L., General Topology, Van Nostrand Reinhold Co., New York, 1995.
5. Hocking, J., Young, G., Topology, Addison-Wesley Reading, 1961.
6. Steen, L., Seebach, J., Counter Examples in Topology, Holt, Reinhart and Winston, New York, 1970.
7. Abhijit Dasgupta, Set Theory, Birkhäuser.

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