Tribhuvan University
Institute of Science and Technology

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Bachelor's in Science (B.Sc.)/B.A.

Mathematics

Course Title : Algebra I
Course No. : 321 (major/ minor)
Level: B.A./B.Sc.
Nature of the course: Theory

Full Mark: 75
Pass Marks: 35%
Year: II
Period per Week: 9
Time per period: 45minutes

Course Structure:

Unit 0. Review of set, relation, mapping and matrices: Set and set operations, relations, mappings, injective, surjective and bijective mapping, composite and inverse mapping, matrices and entries, notation and specification of matrices, standard matrices submatrices and equal matrices.

Unit 1. Matrices and Determinants: Algebra of matrices, Square matrix as product of lower and upper triangular matrices, transpose of a matrix and its properties, partition of matrices, symmetric and skew symmetric matrices, trace of a matrix, matrices of complex entries, Hermitian and skew- Hermitian matrices, orthogonal and unitary matrices, determinant of square matrix, properties of determinants, minors and co-factors, adjoint and inverse of the square matrix and their properties, and related problems. 8 hrs.

Unit 2. System of Linear Equations: System of homogeneous and non-homogeneous linear equations, rank of a matrix, reduction to echelon form, linear dependence and independence, properties of rank, row rank and column rank, rank of the product of matrices, consistency and inconsistency of a system of linear equations, solution of homogeneous and non-homogeneous system of linear equations, elementary transformation of a matrix, inverse of a matrix by elementary transformation, characteristic equation of a matrix , Cayley-Hamilton theorem (no proof) and related problems. 10hrs.

Unit 3. Binary Operation and Properties of Integers: Binary operations, algebraic structure, equivalence relations and equivalence classes, properties of integers and prime number, divisors and greatest common divisor, prime factors and unique factorization theorem (no proof), congruences and residue classes, and related problems. 8hrs.

Unit 4. Groups: Semi-groups and groups and their examples, elementary properties of groups, integral power of an element, cyclic groups, Subgroups and their properties, coset, order of an element, Lagrange's theorem,centre,normalizer and related problems. 10hrs.

Unit 5. Group continued: Permutation groups, cyclic permutation, even and odd permutation, normal subgroup, quotient group and their properties, homomorphism, kernel and image of homomorphism, isomorphism, and related problems. 10hrs.

Unit 6. Rings and Fields: Rings, Special classes of rings, elementary properties of rings, zero divisor, division ring, integral domain, field and their properties, Boolean ring, subrings, ideals and quotient rings, homomorphism of rings, maximal ideal of rings, and related problems. 8hrs.

Unit 7. Vector in Real n-Space: Point in n-space, algebraic operations of points in n-space and their properties, scalar product, norm, distance, angle, scalar and vector projections and their geometrical interpretations, orthogonality,related problems. 6hrs.

Unit 8. Vector Space and Subspaces: Vector space and subspaces, elementary properties, linear combination linear dependence and independence, basis and dimension, direct sum, inner product, orthogonalty and orthonormality, orthogonal and orthonormal basis, and related problems. 8hrs.

Unit 9. Linear Transformations: Transformations, linear transformation, kernel and image of linear transformations, algebra of linear transformation, matrix as a linear transformation, eigenvalues and eigenvectors, and related problems. 8hrs.

Unit 10. Theory of polynomial Equations: polynomial over an integral domain, division algorithm, division of a polynomial, zero of a polynomial, Rolle's theorem(no proof),properties of equations, Descartes rule of signs, relation between roots and coefficients, application to the solution of an equation, symmetric function of roots, transformation of equations, transformation in general, multiple roots, sum of the power of roots, reciprocal equations, Binomial equation and related problems. 10hrs.

Unit 11. Cubic and Biquadratic Equations: Algebraic solution, algebraic solution of the cubic, nature of roots of cubic, equation of square difference of cubic, nature of roots from Cardan's solution and application to the numerical examples, solution by symmetric functions of roots, solution of the biquadratic and the radical and related problems. 8hrs.

Unit12. Numerical solution of equations: Numerical equations, limit of the roots of equations, integer roots, method of divisors, Newton's method of approximation, Horner's method, and related problems. 6hrs.

Book suggested:

1. I.N. Herstein : Topics in Algebra, vikas Publishing House pvt. Ltd.
2. S. Lang: Linear Algebra, Addition-wesley Publicing Company.
3. R.M. Shrestha & S. Bajracharya: Linear Algebra, Groups, Rings &Theory Of Equations, Sukunda Pustak Bhavan, Kathmandu.
4. H.N. Bhattarai and G.P. Dhakal, Undergraduate Algebra,Vidharthi Pustak Bhandar,kathmandu.
5. Chandrika Prasad: A text book of Algebra &Theory of equation, Pothishala private Ltd.
6. P. B.Bhattacharya, S.K. Jain & S.R. Nagpaul: First course in Linear Algebra, New Age International Publisher
7. P. B.Bhattacharya, S.K. Jain & S.R. Nagpaul: Basic Abstract Algebra, Cambridge, 1995.
8. N.S. Gopalakrishnan: University Algebra, Orient Longman.
9. P.R. Halmos: Finite Dimensional Vector Space, D.Van Nostrand co., Princeten.
10. B.S. Vatssa: Theory of Matrices, Wiley Eastern Ltd.
11. A.R. Vasishtha: Modern Algebra,Krishna Prakashan Mandir,Meerut

Math 322
F.M. 75
P.M. 35%
Year: II

Mathematical Analysis I
(Revised)

Unit 1 **Basic Concepts**

Elementary logic

Connectives, Quantifiers, Basic laws of logic, Techniques of proof.

Sets and functions

Sets and set operations, Relations and functions, One-to-one and onto functions, One-to-one correspondence, Images and inverse images, Composition, Inverse functions.

Unit 2 **Real Number System**

Peano's axioms, Field axioms, Order axioms, Bounded and unbounded sets, Supremum and infimum, Completeness axioms, Archimedean property, Well ordering principle, Rational density, Countable and uncountable sets, Cardinality..

Unit 3 **Pointset Topology of the Real Line**

Neighbourhood, Interior points and limit points of a set, Open and closed sets and their properties, Bolzano-Weierstrass theorem, Closure of a set, Derived sets, Perfect sets.

Unit 4 **Sequences of Real Numbers**

Sequences and subsequences, Convergent sequences, Bolzano-Weierstrass theorem for sequences, Cauchy sequences, Convergence criteria, Operations on convergent sequences, Monotonic sequence and convergence, Nested intervals theorem.

Unit 5 **Series of Real Numbers**

Series and sequences, Convergence and divergence, Cauchy's criteria for convergence, Different tests for convergence, Alternating series, Absolute and conditional convergence.

Unit 6 **Limits and Continuity**

Limits, Sequential criterion for limits, One-sided limits, Properties of limits, Continuity of functions, Sequential criterion for continuity, Discontinuities, Continuity and inverse images, Functions continuous on closed intervals, Sign preserving property, Intermediate value theorem, Bolzano's theorem, Uniform continuity, Lipschitz condition, Monotone and inverse functions, Continuous Inverse theorem.

Unit 7 **Differentiation**

Derivative of a real-valued function of a single variable, Differentiability at a point and in an interval, Sequential criterion for derivatives, Differentiability and continuity, Monotonic functions, Rules of differentiation, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem and their geometric interpretations, Higher order derivatives, Taylor's theorem, Maclaurin's theorem and their infinite series form, Applications of Taylor's theorem in extreme values problems, Indeterminate forms, L'Hospital rule.

Unit 8 **Riemann Integration**

Partitions and refinement of partitions, upper and lower integrals, Riemann integrable functions and Riemann integrals, Condition of integrability, Properties of Riemann integrals, Alternative approach: Step function approach to Riemann integration.

Unit 9 **Fundamental Theorems of Calculus**

Primitives, Fundamental theorem of calculus, First mean value theorem, Generalized first mean value theorem, Integration by parts, Change of variable in an integral, Second mean value theorem (particular case).

References:

1 Bajracharya, Prakash Muni: *Real Analysis-An Introduction to Proof*, Buddha Academic Publishers & Distributors Pvt.Ltd., Kathmandu, Nepal
2 Shrestha, R.M.: *Funcamentals of Mathematical Analysis*, Sukunda Pustak Bhawan, Kathmandu, Nepal.
3 Maskey, S.M.: *Principles of Real Analysis*, Bhundipuran Prakashan, Kathmandu, Nepal.
4 Bartle. Robert G. & Sherbert, Donald R.: *Introduction to Real Analysis*, John Wiley and Sons Inc., Singapore.
5 Krishan, Hari, *Real Analysis*, Pragati Prakashan, Meerut, India.
6 Malik, S.C.& Arora, Savita: *Mathematical Analysis*, Wiley Eastern Limited, New Delhi.

Course Title: Calculus
Course No.: 311(major/minor)
Nature of the Course: Theory

Full Marks : 75
Pass Marks: 35%
Year: I

Unit 0. Review of Elementary Calculus: Functions, Graphs Evaluations of limits, Continuity, Discontinuity, Test of continuity and properties of continuous functions. 6hrs

Unit 1. Tangents and Normals.: Tangents and normals, Subtangent, Subnormal and their lengths, Derivative of arc length, Polar equations of subtangent and subnormal, Angle between radius vector and tangent, Length of perpendicular from pole on tangent, Pedal equations and Angle between two curves. 6hrs

Unit 2. Higher Order Derivatives and Mean Value Theorems: Higher order derivatives, Following theorems (without proofs): Rolle's theorem, Langrange's theorem, Cauchy Mean Value theorem, Maclaurin's theorem and Taylor's theorem and their applications in solving problems. 8hrs

Unit 3. Application of Derivatives: Indeterminate forms, L'Hospital's rule (without proof), Asymptotes, Types of asymptotes, Asymptotes of algebraic curves, Curve tracing techniques, Standard curves and their tracing, Curvature, Chord of curvature, Curvature at origin, Center and circle of curvature. 12hrs

Unit 4. Partial Differentiations and Maxima and Minima of Functions of 2 and 3 Variables: Basic ideas of limits and continuity of functions of 2 and 3 variables, Partial derivatives and their geometrical interpretation, Higher order partial derivatives, Homogeneous functions, Euler's theorems (proof for 2 variables only), Total differentials, Extremum values, Stationary points, Criterion for maxima and minima, Subsidiary conditions, Lagrange's method of undetermined multipliers. 8 hrs

Unit 5. Integration and Definite Integrals: Integration concepts, Integration techniques and standard formulae, Integration of rational functions and hyperbolic functions, Integration as the limit of a sum, Definite integral and fundamental theorem of integral calculus (without proof), Properties of definite integral. 6hrs

Unit 6. Beta and Gamma Functions and Reduction formulae: Improper integrals, Beta and Gamma functions and their properties, Reduction formulae. 4hrs

Unit 7. Rectification and Quadrature, Volume and Surface Area of Solid of Revolution: Rectification notion, Length formula, Idea of quadrature and area formula, Volume and surface area of solid of revolution. 8hrs

Unit 8. Double Integrals: Double and iterated integrals in rectangular coordinates, Change of variables in double integrals (to polar coordinates and curvilinear coordinates), Computing area and volume using double integrals, Application of double integrals in mechanics: mass and static moments of a lamina, centre of gravity, moments of inertia of a lamina. 8hrs

Unit 9. Differential Equations of the First Order and the First Degree: Introduction, standard form, Variable-separable equations, Homogeneous equations, Equations reducible to homogeneous equations, Non-homogeneous equation of the first order, Exact differential equation, Condition for exactness, Integrating factors

first order, Exact differential equation, Condition for exactness, Integrating factors and techniques, Linear differential equations and equations reducible to linear forms. 6hrs

Unit 10. Differential Equations of the First Order but not of the First Degree: Equations solvable for p, Equations solvable for y, Equations solvable for x, Equations solvable for x and y, Equations homogeneous in x and y, Clairaut's equation. 6hrs

Unit 11. Linear Differential Equations with Constant Coefficients: Linear equations with constant coefficients, Linear equations solvable using symbolic operators, Symbolic operation techniques, Particular integrals and complementary function, Homogeneous linear equations, Equations reducible to homogeneous form. 6hrs

Unit 12. Applications of the First Order and the First Degree Differential Equations: Formation of problems into differential equations, Initial and boundary conditions, Solution technique. 6hrs

Books Suggested:

1. M.B. Singh and B.C. Bajracharya; *Differential Calculus*, Sukunda Pustak Bhandar, Katmandu, 1995.
2. G.D. Pant and G.S. Shrestha; *Integral Calculus and Differential Equations*, Sunita Prakashan, Kathmandu 1994.
3. D.A. Murray; *Introductory Course in differential Equations*, Orient Longman.
4. T.M. Apostal; *Calculus Vol I & II*, Wiley Eastern Ltd, new Delhi, 1986.
5. Das and Mukherjee; *Differential Calculus*, U.N. Dhar and Sons, Calcutta.
6. Das and Mukherjee; *Integral Calculus*, U.N. Dhar and Sons, Calcutta.
7. S.M. Maskey; *Calculus*, Ratna Pustak Bhandar, Kathmandu, 2008.

Course Title: Analytical Geometry and Vector Analysis
Course No.: 312(major/minor)
Nature of the Course: Theory

Full Marks : 75
Pass Marks: 35%
Year: I

Unit 1. Transformation of Coordinates: Introduction to polar, cylindrical and spherical coordinates, Transformation, Rotation, Process involving combination of translation and rotation of axes, Invariants in orthogonal transformation. 6hrs

Unit 2. Conic Sections and their properties.: Introduction, Conic section as a locus of a point and as a section of a cone, Central conic sections, Ellipse and hyperbola, Derivation of their equations in standard forms, Auxiliary circles and eccentric angle, Equations of tangent and normal, Chord of contact, Pole and polar and their properties, Diameter, conjugate diameter and equi-conjugate diameter, Asymptotes of hyperbola, Relations between the equation of the hyperbola, its asymptotes and the conjugate hyperbola, Equation of a hyperbola referred to the asymptotes as coordinate axes. 14hrs

Unit 3. Polar Equation of a Conic: Polar equation of a conic section with focus being a pole, Equation of the chord of conic, Equation to the tangent, normal and chord of contact, Equation of the polar to a conic and Equation of the asymptotes 6hrs

Unit 4. General Equation of the Second Degree: General equation of the second degree and the conic representation by them, Nature of the conic, Center of conic, Equation of the tangent and condition of tangency, Equation of pair of tangents, Director circle, Equation of the normal to a conic, Equation of pole and polar with respect to a conic, Diameter and conjugate diameters, Intersection of conics, Asymptotes to a conic. 6hrs

Unit 5. Coordinates in three space and Plane: Review of coordinates in space, angle between two lines, General equation of the first degree representing a plane, angle between two planes, Plane through three points, Plane through intersection of the two planes, Condition for representing a pair of planes by the homogeneous equation of the second degree. 6 hrs

Unit 6. Straight lines: Representation of a line as the intersection of two planes, Line in symmetric form, Line through two points, Reduction of the general form to the symmetrical form, Perpendicular distance of a point from a line, Condition for a line to lie in a plane, General equation of a plane containing a line, Coplanar lines and condition for it, Skew lines, Magnitude and equation of the line of shortest distance between two skew lines, Intersection of three planes. 8hrs

Unit 7. Sphere: Sphere and equation of a sphere, Its representation by the general equation of the second degree, Sphere through four given points, Plane section of a sphere, Intersection of two spheres, Sphere with a given diameter, Tangent plane and condition of tangency. 4hrs

Unit 8. Cone and Cylinder: Definition and equation of a cone, Condition that the general equation of the second degree to represent a cone, Condition that a cone has three mutually perpendicular generators, Tangent lines and tangent plane, Condition of tangency, Reciprocal cone, Enveloping and right circular cone, Cylinder and enveloping cylinder, Right circular cylinder. 8hrs

Unit 9. Central Coicoids: Conicoids and central conicoids, Standard equation of the central conicoid, Intersection of a line with a conicoid, Tangent and tangent planes, Condiion of tangence, Director sphere, Equation of the normal, Cubic curve through the feet of the six normals, General equation of the conicoid through the six feet of the normals, Polar plane and plane of contact, Enveloping cone of the central conicoidand enveloping cylinder to a conicoid section of a conicoid, Diametral plane, Conjugate diameters and diametral planes of a ellipsoid, Properties of conjugate semi-diameters. 10hrs

Unit 10. Product of three or more vectors: Multiplication of three vectors, scalar triple product, Applications and geometrical meanings of scalar triple product, Properties of scalar triple product, Condition of coplanarity of three vectors, Vector triple product, Scalar product of four vectors ad vector product of four vectors, Reciprocal system of vectors. 6hrs

Unit 11. Differentiation of Vectors: Vector function of a single variable, Vector function and its expression in terms of unit vectors, Limit and continuity of vector functions, Differentiation of a vector function w.r.t. a scalar, Partial derivatives of vectors, Higher derivatives of a vector function w.r.t. a scalar, Differentiation of the product of a scalar and a vector, Differentiation of scalar product and vector product of two and three vectors. 8hrs

Unit 12. Gradient, divergence and Curl, and Expression Formulae: Scalar point function, Vector point function, Scalar field, Vector field, Vector operators, Gradient scalar field, Gradient in polar coordinates, Condition for a scalar point function to be constant and conversely, Total differential, Directional derivative, Divergence of a vector field, Solenoidal vector, Curl of a vector field, Expansion formulae, Second order differential operators, Expansion formulae involving the first order and the second order differential operators. 8hrs

Books Suggested:

1. Y.R. Sthapit and B.C. Bajracharya; *A Text Book of Three Dimensional Geometry*, Sukunda Pustak Bhandar, Katmandu.
2. S. L. Loney; *Elements of coordinate Geometry*, MacMillan Book Co. NY 984
3. J.T. Bell; *An Elementary Treatise of Coordinate Geometry of Three Dimensions*, MacMillan Book Co. NY 9846
4. M.B. Singh and B.C. Bajracharya; *A Text Book of Vector Alnalysis* , Sukunda Pustak Bhandar, Katmandu
5. S. Narayan; *Analytical Solid Geometry*. S. Chand and Co.
6. Lalji Prasd; *Vector Analysis*, Paramount Publication 1986.
7. M.R. Joshi; *Analytical Geometry*, , Sukunda Pustak Bhandar, Katmandu