B.Sc. Mathematics

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Mathematics
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: MAT 101	
Course Title: BASICS OF MATHEMATICS	
Credits: 2+0	
Unit	**Topics**
	Assignment on "Indian Ancient Mathematics and Mathematicians" should be included under Continuous Internal Evaluation (CIE).
BASICS OF MATHEMATICS	
I	Set theory: Definition of sets, representation of sets, universal set, empty set, singleton set, finite and infinite set, equal set, cardinal number of finite set, equivalent set, set of set, subsets, proper subset, superset, power set, improper set, comparibility of sets, union and intersection of sets, complement of sets, de morgan's law, disjoint sets, difference and symmetric difference, algebra of sets, duality, counting principle, venn diagram and its applications.
II	Ordered pair, Cartesian product of two sets, relations, domain, co-domain and range of a relation, types of relations: identity relation, inverse relation, empty relation, universal relation, reflexive relation, symmetric relation, anti- symmetric relation, transitive relation, equivalence relation. Functions or mapping, domain, co-domain and range of a function, composition of functions, types of function: one-one function, many –one function, onto function, into function, one-one into function, one-one onto function, many- one into function, many-one onto function, and invertible functions.
III	Differentiation of functions, geometrical significance of derivatives, derivative of the product of functions, derivative of quotient of two functions, derivative of a function of function , Maxima and minima of a function of one variable. Integration of functions, properties of indefinite integrals, integration by substitution, integration by parts, integration of rational functions, integration using partial fractions. Definite integrals and its properties.
IV	Principle of mathematical induction, Polynomials, Linear polynomial, quadratic polynomial, cubic polynomial, roots of polynomial, Quadratic equations, Factorisation, Determinants and its applications, matrix theory, types of matrices: Horizontal matrix, vertical matrix, square matrix, row matrix, column matrix, null matrix, identity matrix, diagonal matrix, scalar matrix, sub matrix, triangular matrix, comparable matrix, Operation on matrices: Matrix addition, subtraction, product of matrices, difference of two matrices, transpose of a matrix, inverse of a matrix by adjoin method.

Course Code: MATH 102 (B030101T)	
Course Title: DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS	
Credits: 4+0	
Unit	**Topics**
PART-A **DIFFERENTIAL CALCULUS**	
I	Definition of a sequence, Theorems on limits of sequences, Bounded and Monotonic sequences, Convergent sequence, Cauchy's convergence criterion, BalzanoWeierstrass theorem for sequence, Cauchy sequence, Cauchy's first and second theorems on limits, limit superior and limit inferior of a sequence, Cantor's theorem on nested intervals, subsequence.
II	Limit, Continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem, Bolzano's theorem, Intermediate value theorem, Extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule.
III	Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, and Leibnitz theorem, Maclaurin's and Taylor's series expansion.
IV	Partial differentiation, Euler's theorem on homogeneous function, Jacobians and its properties, Asymptotes, Curvature, Envelops and evolutes, Test for concavity and convexity.
PART-B **INTEGRAL CALCULUS**	
V	Lower and upper bounds, Supremum and infimum of the subsets of R and its basic properties, Completeness of R. Riemann integral and its properties, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.
VI	Beta and Gamma functions, Tracing of curves in Cartesian and Polar forms, Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test.
VII	Areas of Curve, Lengths of curve, Volumes of solid of revolution, Multiple integrals: Double and Triple integrals, Change of order of double integration, Area as a double integral in Cartesian form, Dirichlet's theorem, and Liouville's theorem for multiple integrals.
VIII	Vector Differentiation, Point function, Vector differential operator, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Second order differential operator, Laplacian operator. Vector Integration, Line integral, Circulation, Work done by a force, Surface integral, Volume integral, Gauss, Green, Stokes theorems with prove and related problems.

Course Code: MAT 103 (B030102P)		
Course Title: PRACTICAL		
Credits: 0+2		
Unit	**Topics**	
	• **Practical / Lab work to be performed in ComputerLab.** **List of the practicals to be done using Sage Math / Mathematica / MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	
I.	Plotting the graphs of the following functions: I. ax II. $[x]$ (greatest integerfunction) III. x^{2n}; $n\epsilon N$ IV. x^{2n-1}; $n\epsilon N$ V. $\frac{1}{x^{2n-1}}$; $n\epsilon N$ VI. $\frac{1}{x^{2n}}$; $n\epsilon N$ VII. $\sqrt{ax+b}$,$\lvert ax+b\rvert$ VIII. $\lvert x\rvert$ $for x \neq 0$ IX. $e^{x} for x \neq 0$ X. $e^{-x} for x \neq 0$	
II.	Plotting the graph of the following functions: $\log_e x$, sin x, cos x, tan x, sin hx, cos hx, tan hx.	
III.	Sketching parametric curves: Trochoid, Cycloid, and Epicycloid.	
IV.	By plotting the graph find the solution of the equation: $x = e^x$, $x^2 + 1 = e^x$, $1 - x^2 = e^x$, $x = \log_{10}(x)$, $\cos(x) = x$, $\sin(x) = x$, $\cos(y) = \cos(x)$, $\sin(y) = \sin(x)$.	
V.	Plotting the graphs of polynomial of degree 2, 3, 4 and 5.	
VI.	Find numbers between two real numbers and plotting of finite and infinite subsetof R	
VII	Matrix operations: I. Addition, II. Multiplication, III. Inverse, IV. Transpose.	
VIII	Complex number and their representations: I. Addition, II. Multiplication, III. Division, IV. Modulus.	

Course Code: MAT 104 (B030201T)	
Course Title: MATRICES AND DIFFERENTIAL EQUATIONS	
Credits: 3+0	
Unit	**Topics**
MATRICES AND DIFFERENTIAL EQUATIONS	
I	Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form or Canonical form of a Matrix, Inverse of a Matrix by elementary operations. Complex matrix, Conjugate of matrix, Transpose of Conjugate of matrix, Hermitian matrix and Skew-, Hermitian matrix , Periodic matrix, Idempotent matrix, Unitary matrix. System of linear homogeneous and non-homogeneous equations, Consistency and Inconsistency of a system of linear equations, Theorems on consistency of a system of linear equations, Cramer's Rule.
II	Vector, Linear Dependence and Independence of vectors, Dependence and Independence of vectors of vectors by rank method. Eigen values, Eigen vectors and characteristic equation of a matrix, Orthogonal Vectors. Algebraic Multiplicity, Geometric Multiplicity, Regular eigen value, Caley-Hamilton theorem and its use in finding inverse of a matrix, Diagonalisation of square matrix, Power of matrix by Diagonalisation.
III	Order and Degree of a Differential Equations, Formation of differential equations, General Solution, Particular Solution, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Equation Reducible to Variable separable form, Homogeneous differential equations, Equations Reducible to Homogeneous form.
IV	Exact differential equations and equations reducible to the exact form, Linear differential equations, Equations Reducible to Linear form; First order higher degree differential equations solvable for p, y, x. Clairaut's differential equation, Singular Solutions, Determination of singular solution, Orthogonal Trajectories, Trajectories in Cartesian form and Polar form.

Course Code: MAT 105 (B030201T)	
Course Title: GEOMETRY	
Credits: 3+0	
Unit	**Topics**
GEOMETRY	
I	Three-Dimensional Coordinates in space, Distance between two points, Direction cosines and direction ratios, Projection of a segment on a straight line, Projection of the join of two points on a straight line, Angle between two lines, Distance of a point from a line.
II	Plane, General equation of plane ,Equation of the plane in various forms, Equation of a plane through given points, Straight line in three dimensions, Coplanar lines, The image of a point in a plane, Shortest distance between two lines.
III	Sphere, Equation of a sphere whose centre is given, Intersection of two spheres, Intersection of sphere and a straight line, Cone ,Equation of cone, Equation of right circular cone, enveloping cone.

IV	Cylinder, Right circular cylinder, Enveloping cylinder, Central conicoid, properties of the central conicoid in standard form, the ellipsoid, the hyperboloid one sheet, the hyperboloid of two sheets, intersection of line and a central conicoid, tangent plane, condition of tangency, director sphere, normal to a conicoid, polar plane, diametral plane.

Course Code: MAT 201(B030301T)	
Course Title: ALGEBRA	
Credits: 3+0	
Unit	**Topics**
ALGEBRA	
I	Properties of Integers, Divisor, Division algorithm. Greatest Common Divisor, Euclidean algorithm, Fundamental theorem of arithmemetic, Congruences and residue classes. Euler $\emptyset$ − function and its properties, Euler's, Fermat's and Wilson's theorem.
II	Algebraic Structure, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups, Order of an element of a group, Centre of group.
III	Permutation groups, Cyclic permutation, Transposition, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences.
IV	Homomorphism and isomorphism, Kernel of homomorphism, Normal subgroups, Simple group, Quotient groups, Fundamental theorem of homomorphism, Theorems on isomorphism.

Course Code: MAT 202(B030301T)	
Course Title: MATHEMATICAL METHODS	
Credits: 3+0	
Unit	**Topics**
MATHEMATICAL METHODS	
I	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method. Exponential functions, hyperbolic functions, logarithm of a complex number,general exponential function. Inverse Circular function of complex quantities, inverse hyperbolic functions.
II	Laplace transform, Existence theorem for Laplace Transform, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Heaviside expansion formula. Initial and Final value theorem, Unit step function and their properties. Laplace transform of periodic function, Unit impulse function, Inverse Laplace transforms, Convolution theorem, Solution of ordinary differential equation by using Laplace transform.
III	Periodic functions, Fourier series, Fourier expansion of piecewise monotonic functions, Fourier series for even and odd functions, Half - range expansions. Fourier transforms (finite and infinite) and properties of fourier transform.
IV	Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives.

Course Code: MAT 203 (B030401T)	
Course Title: DIFFERENTIAL EQUATIONS	
Credits: 3+0	
Unit	**Topics**
	DIFFERENTIAL EQUATIONS
I	Linear differential equation with constant coefficients, Homogeneous Linear differential equation with constant coefficients, Equation Reducible to Homogeneous form.
II	Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, Changing the independent variable, method of variation of parameters.
III	Ordinary Simultaneous Differential Equation, Method of solving simultaneous linear differential equation with constant coefficients, Solution of simultaneous differential equation in a different form
IV	Total differential equation, Necessary and sufficient condition for Integrability of total differential equation, Methods for solving the total differential equation: Soluion by inspection, one variable regarded as constant, homogeneous equations, method of auxiliary equations.

Course Code: MAT 204 (B030401T)	
Course Title: MECHANICS	
Credits: 3+0	
Unit	**Topics**
	MECHANICS
I	Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and null planes. Conjugate lines and conjugate forces.
II	Analytical conditions of equilibrium of coplanar forces, Virtual work, Stable and unstable equilibrium, Catenary, Catenary of uniform strength.
III	Motion in a straight line: velocity and acceleration, Accelerations in terms of different coordinate systems. Elastic and inelastic collisions between two objects, The coefficient of restitution, Motion in a plane: velocity and acceleration along radial and transverse direction, velocity and acceleration along tangential and normal directions, Elastic strings.
IV	Motion in resisting medium, Projectile motion in resisting medium Moments and products of inertia. The momental ellipsoid. Equimomental systems. Principle axes. Central orbits. Apses and apsidal distances. Kepler's laws of planetary motion, Motion of a particle in three dimensions.

Course Code: MAT 301 (B030501T)	
Course Title: RING THEORY AND LINEAR ALGEBRA	
Credits: 4+0	
Unit	**Topics**
PART-A RING THEORY	
I	Introduction to rings, integral domains and fields, Characteristic of a ring, Ring homomorphism, Ideals and quotient rings.
II	Field of quotients of an integral domain, Euclidean domain, Prime and maximal ideals, principal ideal domain, Principal ideal rings, Polynomial rings over commutative rings.
III	Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].
IV	Divisibility in integral domains, Irreducible, Primes, Unique factorization domains, Euclidean domains.
Unit	**Topics**
PART-B LINEAR ALGEBRA	
V	Vector spaces, Vector Subspaces, Linear combination, Linear independence and dependence of vectors, same and same spaces, Basis and Dimension, Quotient space.
VI	Linear transformations, The Algebra of linear transformations, Rank Nullity theorem, their representation as matrices.
VII	Linear functionals, Dual space, Dual Basis and Dimension, Bilinear and Quadratic forms.
VIII	Change of basis, diagonal forms, triangular forms, Inner product spaces and norms, Orthogonal vectors, Orthonormal sets and bases.

Course Code: MAT 302 (B030502T)	
Course Title: TENSOR ANALYSIS	
Credits: 3+0	
Unit	**Topics**
TENSOR ANALYSIS	
I	Tensor : Transformation of coordinates, Contravariant and covariant vectors and tensors, Scalar invariants, Mixed tensors, Symmetric and skew –symmetric tensor, Algebra of tensors, Contraction and inner product, Quotient law, Reciprocal tensors.
II	Associated tensors, Length of a vector, Unit Vector, Null vector and orthogonal vector, Riemannian Metric and Space and Christoffel symbols.
III	Covariant differentiation of vector and tensor, Ricci's theorem, Gradient of scalar, Divergence of a contravariant vector , covariant vector and conservative vector, Divergence of a contravariant tensor of order two, Divergence of a mixed tensor of type (1,1), Laplacian of an invariant ,curl of a covariant vector **.**
IV	Riemannian curvature tensor and their properties, Flat space, Ricci tensor and scalar curvature, Einstein space and Einsteintensor.

Course Code: MAT303 (B030502T)	
Course Title: DIFFERENTIAL GEOMETRY	
Credits: 3+0	
Unit	**Topics**
PART-A DIFFERENTIAL GEOMETRY	
I	Local theory of curves –space curves, Regular curve and Plane curve, twisted curve, equation of a plane and straight line, equation of curves in space, length of a curve, tangent to curve, Order of contact between curves and surfaces, osculating plane , equation of osculating plane, equation osculating plane at a point of curve of intersection of two surfaces. Tangent, principal normal and binormal, normal plane and rectifying plane.
II	Curvature and torsion, Serret-Frenet formulae, Direction cosines of the principal normal and binormal, Osculating circle, Osculating sphere. Involutes and evolutes of curves Curve on surface, Regular point and Singularities of surface, transformation of parameters, Parametric curves, tangent plane and normal line, First fundamental form and arc length. Angle between two curves on surface.
III	Special tensors and its properties, orthogonal trajectories, Differential equation of orthogonal trajectories. Second fundamental form of surface, Geometric interpretation of the second fundamental form, Gauss and Weingarten equation.
IV	Identities based on Weingarten equation, Normal curvature and its equation, Meusnier's theorem. Definition and Basic Properties of Geodesics, Geodesic Equation.

Course Code: MAT 304 (B030601T)	
Course Title: METRIC SPACES AND COMPLEX ANALYSIS	
Credits: 4+0	
Unit	**Topics**
PART-A METRIC SPACES	
I	Definition of a Metric Space, Examples of Metric Space, Bounded and Unbounded Metric Space, Pseudo-metric, Subspace of a Metric Space, Diameter of a Subset of a Metric Space, Distance of a Point from a Non-empty set, Distance between two Non- empty Subsets of a Metric Space. Open and Closed Spheres, Neighborhood of a point, Interior Point and Interior of a Set, Open sets, Equivalent Metrics, Exterior, Frontier and Boundary of a Set, Limit Point and Isolated Point, Derived Set, Closed Set, Closure of a Set ,Dense Sets and Separable Spaces.
II	Subspace of a Metric Space, Examples, Sequence in a Metric Space, Convergence in a Metric Space Cauchy Sequence, Complete Metric Space, Isometry and Isometric Space.
III	Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.
IV	Cover, Compact Sets and compact Space, Finite Intersection Property and Compactness, Continuity and Compactness, Sequentially Compactness. Separated Sets, Disconnected Space and Disconnected Sets, Connected Space and Connected Sets, Components.
Unit	**Topics**
PART-B COMPLEX ANALYSIS	
V	Complex numbers as ordered pairs, geometric representation of complex number, Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.
VI	Complex integration, Cauchy-Goursattheorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Liouville's Theorem.
VII	Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic, De Morgan and Cauchy's condensation test, Taylor Series, Laurent Series and its examples.
VIII	Zeroes and poles of order m, Isolated singular points, Types of isolated singular points , Residues, Residues at poles and its examples, Residue at infinity, Cauchy's residue theorem, Evaluation of improper real integrals, Definite integrals involving sines and cosines.

Course Code: MAT 305 (B030602T)	
Course Title: NUMERICAL ANALYSIS AND OPERATIONS RESEARCH	
Credits: 4+0	
Unit	**Topics**
PART-A **NUMERICAL ANALYSIS**	
I	Error in numerical computations ,Calculus of finite differences, Difference operators, Fundamental theorem of differential calculus, Interpolation with equal and unequal intervals, Newton's forward and backward interpolation formulae, Divided difference interpolation formula, Lagrange's interpolation formula.
II	Solutions of algebraic and transcendental equations, Direct and iterative methods,, Bisection method, Regula-falsi method, Newton- Raphson method, Iteration method. Solution of simultaneous linear equations: Gauss-elimination method, Guass-Jordan method, LU decomposition method, Guass-Seidel method.
III	Numerical differentiation derivatives using forward and backward formula, Numerical Integration, General Quadrature formula, Trapezoidal rule, Simpson's one-third and tree-eight formulae and Weddle's rules.
IV	Numerical solution of ordinary differential equation, Picard method, Taylor series method, Euler's method, Modified Euler's method, Runge-Kutta method.
PART-B **OPERATIONS RESEARCH**	
V	Developing mathematical models, Mathematical programming, Linear programming, Convex sets, Convex and concave functions, Theorems on convexity, Linear programming problem (LPP), Simple and general LPP, Solutions of simple LPP by graphical method, Analytical solution of general LPP, Canonical and standard forms of LPP, Slack and surplus variables.
VI	Solution of general LPP by Simplex method. Use of artificial variables in simplex method, Big-M method and Two-Phase method, Concept of duality in linear programming, Theorems on duality, Dual simplex method.
VII	Transportation problem, Solution of transportation problem, Methods for finding Initial basic feasible solution of transportation problem, Optimal solution of transportation problem by modified distribution (MODI) method, Degeneracy in transportation problem, Maximization transportation problem. Assignment problem, Balanced and unbalanced assignment problems. Solution of assignment Problem, Hungarian Method, Maximization Assignment problem.
VIII	Game Theory: Competitive game, Two-Person Zero-Sum (Rectangular) game, Minimax-maximin criteria, Saddle points, Solution of rectangular game with and without saddle points, Huge rectangular games, Dominance rules, Solution of huge rectangular games using rules of dominance, Graphical method for 2xn and mx2 games without saddle points.

Course Code: MAT 306 (B030603T)		
Course Title: PRACTICAL		
Credits: 2+0		
Unit	**Topics**	
	• **Practical / Lab work to be performed in Computer Lab.** **List of the practicals to be done using Sage Math / Mathematica / MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	
I.	Solution of transcendental and algebraic equations by i. Bisection method ii. Regula Falsi method iii. Newton Raphson method iv. Iteration method	
II.	Solution of system of linear equations by i. LU decomposition method ii. Gaussian elimination method iii. Gauss-Seidel method	
III.	Interpolation by i. Newton's forward Interpolation ii. Newton's backward Interpolation iii. Lagrange Interpolation iv. Divided difference interpolation formula	
IV.	Numerical Integration by i. Trapezoidal Rule ii. Simpson's one third rule	
V.	Numerical Integration by i. Simpson's three-eight rule ii. Weddle's Rule	
VI.	Solution of ordinary differential equations by i. Euler method ii. Runge Kutta method	
VII.	Solution of ordinary difference equations by Picard method.	
VIII.	Solution of ordinary difference equations by Taylor series method.	