**THREE YEARS DEGREE COURSE SYLLABUS FOR**

# MATHEMATICS

**(BASED ON UNIFORM SYLLABUS FOR U.P.STATE UNIVERSITIES)**

**For B.A./B.Sc. Classes (From onwards)**

**B.A./B.Sc. 1st Year**

**Paper 1 :** **ALGEBRA AND TRIGONOMETRY** **M.M.: 65**

## ALGEBRA

**UNIT 1 :** Equivalence relation and partitions ,Congruence modulo m relation, Definition of a group with examples and simple properties, Subgroups, Permutation groups ,Order of elements of a group, Cyclic groups, Cosets, Lagrange's theorem and its consequences.

**UNIT 2 :** Homomorphism and isomorphism, Cayley's theorem ,Normal subgroups,Quotient groups, Centre and Normalizer, Fundamental theorems on homomorphism and isomorphism, Congugacy relation and class equation.

**UNIT 3 :** Definition of rings with examples and simple properties, Subrings, Integral domains, Division rings, Skew field, Fields, Characteristic of a ring, Homomorphism of rings, Ideals, Quotient rings, Field of fractions.

## TRIGONOMETRY

**UNIT 4 :** Complex functions and separation into real and imaginary parts, Exponential, Direct and inverse trigonometric and hyperbolic functions ,Logarithmic functions , Gregory's series , Summation of series.

**Paper 2 :** **CALCULUS** **M.M.: 65**

## DIFFERENTIAL CALCULUS

**UNIT 1 :** $\varepsilon - \delta$ definition of the limit of the function , Continuous functions and classification of discontinuities, Differentiability, Chain rule of differentiability, Roll's theorem, First and second mean value theorems ,Successive differentiation, Leibnitz's theorem with proof and its applications.

**UNIT 2 :** Expansion of functions in Taylor's and Maclaurin's series , Indeterminate forms , Partial differentiation and Euler's theorem , Jacobians, Asymptotes.

**UNIT 3 :** Curvature, Envelopes, Envolute, Maxima and minima for functions of two variables, Test for concavity and convexity, Points of inflexion ,Multiple points, Tracing of curves in Cartesian and polar co-ordinates.

## INTEGRAL CALCULUS

**UNIT 4 :** Reduction formulae, Beta and Gama functions, Quadrature , Rectification , Volumes and surfaces of solids of revolution ,Double and triple integrals ,Change of order of integration.

**Paper 3: GEOMETRY AND VECTOR CALCULUS M.M.70**

## GEOMETRY

**UNIT 1:** General equation of second degree , Tracing of conics , System of conics , Confocal conics , Polar equation of a conic and its properties.

**UNIT 2:** Three dimensional system of coordinates , Projection and direction cosines ,Plane, Straight line. Sphere.

**UNIT 3 :**Cone, Cylinder, Central conicoids , Tangent Plane and normal to a Conicoid , Pole and Polar, Conjugate diameters ,Generating lines, Plane section.

## VECTOR CALCULUS

**UNIT 4 :** Vector differentiation and integration ,Gradient ,Divergence and curl and their properties ,Line integrals , Theorems of Gauss, Green and Stokes and problems based on these.

# B.A./ B.Sc. 2nd Year

**Paper 1 LINEAR ALGEBRA AND MATRICES M.M.65**

## LINEAR ALGEBRA

**UNIT 1 :** Vector spaces and their elementary properties , Subspaces ,Linear dependence and independence, Basis and dimension , Direct sum ,Quotient space.

**UNIT 2 :** Linear transformation and their algebra ,Range and null space ,Rank and nullity , Matrix representation of linear transformation , Change of basis.

**UNIT 3 :** Linear functionals , Dual spaces ,Bi-dual space , Annihilators , Bilinear and quadratic forms ,Inner product spaces , Cauchy- Schwarz's inequality, Bessel's inequality, Orthogonality .

## MATRICES

**UNIT 4 :**Symmetric and skew – symmetric matrices ,Hermitian and Skew– Hermitian matrices, Orthogonal and unitary matrices, Triangular and diagonal matrices, Rank of a matrix, Elementary transformations ,Echelon and normal forms .

Characteristic equation ,Eigen values and eigen vectors of a matrix,Caley- Hamilton 's theorem and its use in finding inverse of a matrix , Diagonalization of square matrices with distinct eigen values , Quadratic forms.

**Paper 2 DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS M.M.65**

## DIFFERENTIAL EQUATIONS

**UNIT 1:** Differential equations of first order and first degree : Separation of variables method, Solution of homogeneous equations , linear equations and exact equations, Linear differential equations with constant coefficients, Homogeneous linear differential equations.

**UNIT 2:** Differential equations of the first order but not of the first degree, Clairaut's equation and singular solutions, Orthogonal trajectories ,Simultaneous linear differential equations with constant coefficients, Linear differential equations of the second order including the method of variation of parameters.

**UNIT 3:** Order, degree and formation of partial differential equations, Partial differential equation of the first order, Lagrange's equation, Charpit's general method, Integral surfaces through a given characteristics curves, Linear partial differential equations with constant coefficient. Partial differential equation of the second order, Monge's method, Reduction to canonical form ,Classification of second order PDE's.

## INTEGRAL TRANSFORMS

**UNIT 4 :** The concept of transform , Integral transforms and kernel ,Linearity property of transforms , Laplace transform, Inverse Laplace transform, Convolution theorem, Applications of Laplace transform to solve ordinary differential equations. Introduction to Fourier transform.

**Paper 3** **MECHANICS** **M.M.70**

## DYNAMICS

**UNIT 1:** Velocity and Acceleration along radial and transverse direction and along tangential and normal direction ,S.H.M., Elastic strings .

**UNIT 2:** Motion under other law of forces, Earth attraction, Motion in resisting medium, Constrained motion (circular and cycloidal motion only)

**UNIT 3:** Central orbits, Apse, Kepler's laws, Motion of particle in three dimensions.

## STATICS

**UNIT 4:** Common Catenary, Stable and unstable equilibrium ,Virtual work, Forces in three dimensions , Poinsot's central axis , Wrenches , null line and null plane.

# B.A. / B.Sc, 3rd Year

**Paper 1** **REAL ANALYSIS** **M.M.75**

**UNIT 1:** Completeness property in R , Archimedean property , Countable and uncountable sets, Neighbourhood, Interior points, Limit points, Open and closed sets, Derived sets, Dense sets, Perfect sets , Bolzano-Weierstrass theorem.

**UNIT 2 :**Sequences of real numbers, Bounded and monotonic sequences, Convergent sequences, Cauchy's theorems on limits, Cauchy sequence , Cauchy's general principle of convergence, Convergence of infinite series , Comparision test , Ratio test , Logarithmic ratio test, Cauchy's condensation test, De Morgan and Bertrand test, Higher logarithmic ratio test, Alterrnating series, Leibnitz's test.

**UNIT 3:** Absolute and conditional convergence, Uniform convergence of sequences and series of functions ,Weierstrass M test, Abel's and Dirichlet's test, Sequential continuity Boundeness and intermediate value properties of continuous functions, Uniform continuity , Meaning of sign of a derivative , Darboux theorem **.**

**UNIT 4:** Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus. Improper integrals and their convergence ,Comparision test, μ- test , Ablel's test ,Dirichlet's test, Integral as a function of a parameter and its differentiability and integrability.

**Paper 2** **COMPLEX ANALYSIS** **M.M.75**

**UNIT 1:** Function of complex variable , Concept of limits , continuity and differentiability of complex functions , Analytic functions, Cauchy-Riemann equations (Cartesian and Polar form), Harmonic functions, Orthogonal system**,** Power series as an analytic function.

**UNIT 2:** Elementary functions , Mapping by elementary functions , Linear and bilinear transformations, Fixed points , Cross ratio , Inverse points and critical points ,Conformal transformations $w=z^2$ , $w= (z+ 1/z)/2$, $w=\log z$ and $w= \tan^2 z/2$ simple functions and properties.

**UNIT 3:** Complex integration , Line integral ,Cauchy's fundamental theorem, Cauchy's integral formula ,Morera's theorem , Liouville theorem , Maximum Modulus theorem, Taylor & Laurrent series .

**UNIT 4:** Singularities and zeros of an analytic function , Rouche's theorem , Fundamental theorem of algebra .Residues theorem and its application to the evaluation of definite integrals.

**Paper 3** **NUMERICAL ANALYSIS** **M.M.75**

**UNIT 1:** Shift operator, Forward operator and backward difference operators and their relationships, Fundamental theorem of difference calculus , Interpolation , Newton-Gregory's forward and backward interpolation formulae.

**UNIT 2:** Divided differences, Newton's divided difference formula , Lagrange's interpolation formula ,Central differences, Formulae based on central differences : Gauss, Striling, Bessel's and Everet's interpolation formulae, Numerical differentiation.

**UNIT 3:** Numerical integration , General quadrature formula , Trapezoidal and Simpson's rules, Cote's formula , Numerical solution of first order differential equations , Euler's method, Picard's method , Runge-Kutta method and Milne's method , Numerical solution of linear homogeneous and simultaneous difference equations .

**UNIT 4:** Solution of transcendental and polynomial equations by iteration , bisection , Regula-Falsi and Newton Raphson methods, Algebraic eigen value problems: Power and Jacobi Method Approximation : Different types of approximations, Least square polynomial approximation, Polynomial approximation using orthogonal polynomials, Legendre's approximation , Approximation with trigonometric functions, Exponential functions ,Rational functions, Chebyshev polynomials.

## Paper 4: DIFFERENTIAL GEOMETRY AND TENSOR ANALYSIS

### DIFFERENTIAL GEOMETRY

**M.M.75**

**UNIT 1 :** Local theory of curves- Space curves, Plane curves, tangent, normal and binomial, Contact between curve and surfaces, Osculating plane, normal and rectifying plane ,Helices, Serret- Frenet apparatus , Intrinsic equations, Fundamental existence theorem for space curve, Involutes and evolutes of curves.

Local theory of surfaces- General surfaces of revolutions , Anchor ring , Helicoids, First and second fundamental forms.

**UNIT 2:** Local theory of surfaces (continued). Direction coefficients, families of curves , Geodesics, Canonical geodesic equations, normal properties of geodesic, Geodesic curvature, Gauss-Bonnet theorem, Gaussian curvature, Normal curvature ,Principal curvature, Mean curvature, Minimal surface, Line of curvature , Meusnier's theorem, Rodrigue's formula.

**UNIT 3:** Euler's theorem, Dupin's theorem, Weingarten equation, Equation of Gauss , Characteristic equation, The Mainardi-Codazzi equation , Tensor algebra : Vector spaces Dual spaces , Tensor product of vector spaces.

Elements of general Riemannian Geometry – Riemannian metric Fundamental theorem of local Riemannian geometry, Riemannian space, Fundamental tensor, Curvature tensor, Properties of curvature tensor, Ricci tensor, Bianchi's identities, Geodesics equation.

### TENSOR ANALYSIS

**UNIT 4:** Contravariant and covariant vectors and tensors, Mixed tensors ,Symmetric and skew – symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem , Christoffel's symbols ,Covariant differentiation ,Ricci's theorem, Gradient ,Divergence and Curl in tensor notation with problems.