BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD, JHARKHAND.

FYUGP Syllabus
MATHEMATICS

FYUGP Syllabus: Mathematics
Major (MJ) – 1

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
First (Foundation or Introductory Courses) Semester - I	**Calculus and Geometry** **Unit 1: (Application of Differential Calculus)** Successive differentiation, Leibnitz theorem. L'Hospital's Rule, Curvature, convexity and concavity. Tangent, Normal, Asymptotes. Derivations and illustrations of reduction formulae of the type $\int sin^n x\,dx$, $\int cos^n x\,dx$, $\int tan^n x\,dx$, $\int sin^n x cos^m x\,dx$, $\int \sin nx\,dx$, $\int \cos nx\,dx$, $\int (logx)^n dx$, etc. Arc length of a curve, arc length of parametric curves, area enclosed by a curve, area between two curves, area and volume of revolution. (3 Questions) **Unit 3: (2D Geometry)** Reflection properties of conics, rotation of axes and second-degree equations, classification of conics using the discriminant, tangent and normal, polar equations of conics. (2 Questions) **Unit 4: (Vector Calculus)** Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions. (1 Question) **Textbooks:** 1. Ghosh, R K, and Maity, K C, An Introduction to Analysis: Differential Calculus: Part I, New Central Book Agency. 2. Ghosh, R K, and Maity, K C, An Introduction to Analysis: Integral Calculus, New Central Book Agency. 3. Advanced Analytical Geometry: J. G. Chakravorty and P. R. Ghosh (U. N. Dhur and Sons 4. K. C. Maity, and R. K. Ghosh, Vector Analysis, New Central Book Agency (P) Ltd. Kolkata.

FYUGP Syllabus: Mathematics
Major (MJ) – 2

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
First (Foundation or Introductory Courses) Semester - II	**Real Analysis-I** **Unit 1:** Review of Algebraic and order properties of $\mathbb{R}$, ε-neighborhood of a point in $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of $\mathbb{R}$ and its equivalent properties. Archimedean property, density of rational (and irrational) numbers in $\mathbb{R}$, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in $\mathbb{R}$, Heine-Boreal Theorem. (1 Question) **Unit 2:** **Sequences:** Sequence, bounded sequence, convergent sequence, limit of a sequence, lim inf, 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. (3 Questions) **Unit 3:** **Series:** 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, integral test. Alternating series, Leibniz test. Absolute and conditional convergence. (2 Questions) **Textbooks:** 1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002. 2. S. C. Malik, Savita Arora, Mathematical Analysis. 3. S. K. Mapa, Introduction to Real Analysis.

FYUGP Syllabus: Mathematics
Major (MJ) – 3

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
First (Foundation or Introductory Courses) Semester - II	**Higher Algebra & Trigonometry** **Unit 1: (Complex numbers)** Polar representation. De Moivre's theorem for rational indices and its applications. Trigonometric, logarithm, exponential and hyperbolic functions of complex variable. (1 Question) **Unit 2: (Matrix Theory)** Inverse of a Matrix, Invertible matrices, Rank of a matrix, row and column rank. Determination of rank using elementary operations, echelon matrices, normal form. System of linear equations: homogeneous system, non-homogeneous system, Linear independence of solutions. (2 Questions) **Unit 3:** Introduction to Linear Transformation, Matrix representation of Linear Transformation, Subspaces of $\mathbb{R}^n$, dimension of subspaces of $\mathbb{R}^n$. Characteristics polynomial, characteristics equation, Eigenvalues and eigenvectors of a matrix. Cayley-Hamilton Theorem. (3 Questions) **Textbooks:** 1. Hoffman, K and Kunze, R, A, Linear Algebra, Prentice Hall of India Pvt Ltd. 2. Kumaresan, S, Linear Algebra – A Geometric Approach, Prentice Hall of India, 1999. 3. Mapa, S K, Higher Algebra: Classical, Sarat Book House.

FYUGP Syllabus: Mathematics
Major (MJ) – 4

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Foundation or Introductory Courses) Semester - III	**Differential Equation** **Unit 1:** Definition and examples of Ordinary Differential equations (ODEs). Formulation of ODE by eliminating parameters. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. (2 Questions) **Unit 2:** General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters. (3 Questions) **Unit 3:** Bessel's equation and Legender's equation, recurrence formulae, orthogonal properties, generating function. Laplace transform and inverse transform, application to initial value problem upto second order ODE. (1 Question) **Textbooks:** 1. Ghosh, R K, and Maity K C, An Introduction to Differential Equations, New Central Book Agency. 2. Raisinghania, M D, Ordinary and Partial Differential Equation, S Chand Publishing. 3. Ross, S L, Differential Equations, Wiley.

FYUGP Syllabus: Mathematics
Major (MJ) – 5

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Foundation or Introductory Courses) Semester - III	**Theory of Real Functions** **Unit 1:** 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. 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. (2 Questions) **Unit 2:** Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, absolute 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. (3 Questions) **Unit 3:** Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of reminder, application of Taylor's theorem to convex functions. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $log(1 + x)$, $1/(ax + b)$ and $(x + 1)^n$. Application of Taylor's theorem to inequalities. (1 Question) **Textbooks:** 1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002. 2. S. C. Malik, Savita Arora, Mathematical Analysis. 3. S. K. Mapa, Introduction to Real Analysis.

FYUGP Syllabus: Mathematics
Major (MJ) – 6

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Foundation or Introductory Courses) Semester - IV	**Group theory I** **Unit 1:** Definition and examples of groups including elementary properties of groups. Subgroups and examples and theorems on subgroups, normal subgroup, centralizer, normalizer, center of a group. (2 Questions) **Unit 2:** 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. (2 Questions) **Unit 3:** Factor groups, Cauchy's theorem for finite Abelian groups. Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second, and Third Isomorphism theorems. (2 Questions) **Textbooks:** 1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999. 2. D.S. Malik, J.N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra. Mc Graw-Hill, International Edition, 1997.

FYUGP Syllabus: Mathematics
Major (MJ) – 7

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Foundation or Introductory Courses) Semester - IV	**Partial Differential Equation & Systems of Ordinary Differential Equation** **Unit 1:** 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, Lagrange's equations, Method of Separation of Variables for solving first order partial differential equations. (2 Questions) **Unit 2:** Introduction of Heat equation, Wave equation, and Laplace equation. Classification of second-order linear equations as hyperbolic, parabolic, or elliptic. Reduction of second-order Linear Equations to canonical forms. (2 Questions) **Unit 3:** Nonlinear partial differential equation, standard forms I, II, III, and IV, Charpit's method, Monge's method to solve equations of the forms: (i) $Rr + Ss + Tt = V$ (ii) $Rr + Ss + Tt + U(rt = s^2) = V.$ (2 Questions) **Textbooks:** 1. T. Amarnath, An Elementary Course in Partial Differential Equations. 2. K. Sankar Rio, Partial differential equations, new age.

FYUGP Syllabus: Mathematics
Major (MJ) – 8

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Foundation or Introductory Courses) Semester - IV	**Numerical Methods** **Unit 1:** Algorithms, Convergence, Errors: Relative, Absolute. Transcendental and Polynomial equations: Bisection method, Newton's Method. (1 Question) **Unit 2:** System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi Method. Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton's Gregory forward and backward difference interpolation. (2 Questions) **Unit 3:** Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's rule, Simpson's 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule. Ordinary differential equations: Euler's method, Runge-Kutta methods of orders two and four. (3 Questions) **Textbooks:** 1. S. A. Molla, Numerical Analysis and Computational Procedures. 2. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New Age International Publisher, India, 2007.

FYUGP Syllabus: Mathematics
Major (MJ) – 9

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Third (Foundation or Introductory Courses) Semester - V	**Riemann Integration & Sequence and Series of Functions** **Unit 1:** Riemann integration; inequalities of upper and lower sums; 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 theorems of Calculus. (2 Questions) **Unit 2:** Improper integrals and their convergence, 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. (2 Questions) **Unit 3:** Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem. (2 Questions) **Textbooks:** 1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002. 2. S. C. Malik, Savita Arora, Mathematical Analysis. 3. S. K. Mapa, Introduction to Real Analysis.

FYUGP Syllabus: Mathematics
Major (MJ) – 10

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Third (Foundation or Introductory Courses) Semester - V	**Ring Theory & Linear Algebra I** **Unit 1:** Definition and examples of rings, properties of rings, subrings, integral domains, and fields, characteristic of a ring, ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. (2 Questions) **Unit 2:** Ring homomorphisms, properties of ring homomorphisms, isomorphism theorems I, II, and III for quotient rings. Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces theorems. (2 Questions) **Unit 3: (Linear Transformation)** Linear transformations, null space, range, rank and nullity of a linear transformation, Matrix representation of linear transformation, algebra of linear transformations, isomorphism theorems, invertibility and change of coordinate matrix. (2 Questions) **Textbooks:** 1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999. 2. D.S. Malik, J.N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra. Mc Graw-Hill, International Edition, 1997. 3. Hoffman, K and Kunze, R, A, Linear Algebra, Prentice Hall of India Pvt Ltd. 4. Kumaresan, S, Linear Algebra – A Geometric Approach, Prentice Hall of India, 1999.

FYUGP Syllabus: Mathematics
Major (MJ) – 11

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Third (Foundation or Introductory Courses) Semester - V	**Multivariate Calculus** **Unit 1:** Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives. Extrema of functions of two variables, method of Lagrange multipliers. (2 Questions) **Unit 2:** Double integration over a rectangular region, double integration over a non-rectangular region. Double integrals in polar coordinates, triple integrals, triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals. (2 Questions) **Unit 3:** The gradient, maximal and normal property of the gradient. Tangent planes. Definition of vector field, divergence and curl. Line integrals. Applications of line integrals, work done by a force field, conservative and non-conservative vector fields. Independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces, Stokes' theorem. (2 Questions) **Textbooks:** 1. S. C. Malik, Savita Arora, Mathematical Analysis. 2. Ghosh, R K, and Maity, K C, An Introduction to Analysis: Integral Calculus, New Central Book Agency.

FYUGP Syllabus: Mathematics
Major (MJ) – 12

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title: **Operation Research**
Third (Higher-Level Courses) Semester - VI	**Study Materials** **Unit 1: Linear Programming Problems** Formulation and examples, Canonical and Standard forms, Graphical solution, Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points. Optimality criterion, improving a basic feasible solution, Unboundedness, Simplex algorithm and its tableau format, artificial variables, Two-phase method, Big-M method. (02 Questions) **Unit 2: Simplex Method & Game Theory** Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, solving the primal problem using duality theory. Formulation of two-person zero-sum games, Games with mixed strategies, Graphical method for solving matrix games, Dominance principle, Solution of game problem, Linear programming method of solving a game. (02 Questions) **Unit 3: Transportation and Assignment Problems** Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, least cost method, Vogel approximation method, Algorithm for obtaining optimal solution; Formulation of assignment problems, Hungarian method. (02 Question) **Textbooks & References:** 1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition). John Wiley & Sons. 2. G. Hadley (2002). Linear Programming. Narosa Publishing House. 3. Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). McGraw-Hill Education. 4. Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.

FYUGP Syllabus: Mathematics
Major (MJ) – 13

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title: **Linear Algebra**
Third (Higher-Level Courses) Semester - VI	**Study Materials** **Unit 1: Vector Spaces** Definition and examples of vector space and Subspace, Linear span Quotient space and direct sum of subspaces, linearly independent and dependent sets, Bases, and dimension. (02 Questions) **Unit 2: Linear Transformations** Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem. Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and Eigen values of a linear transformation, Characteristic polynomial and Cayley-Hamilton theorem, Minimal polynomial. (02 Questions) **Unit 3: Inner Product Spaces and Adjoint Operators** Inner product spaces and orthogonality, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization, Diagonalization of symmetric matrices. Adjoint of a linear operator; Hermitian, Unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces. (02 Questions) **Text Books & References:** 1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). Linear Algebra (4thedition). Prentice-Hall of India Pvt. Ltd. 2. Dr. Manoranjan Kumar Singh, Group Theory II, 1 st Edition, S. Chand, Publication 2022. 3. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall. 4. I. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications.

FYUGP Syllabus: Mathematics
Major (MJ) – 14

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title: **Probability & Statistics**
Third (Higher-Level Courses) Semester - VI	**Study Materials** **Unit 1: Probability Functions and Moment Generating Function** Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables -Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function. (02 Questions) **Unit 2: Univariate Discrete and Continuous Distributions** Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. (02 Questions) **Unit 3: Bivariate Distribution, Correlation and Regression** Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations. The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers. (02 Questions) **Textbooks and References:** 1. Jim Pitman (1993). Probability, Springer-Verlag. 2. Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier. 3. A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi. 4. Irwin Miller &Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.

FYUGP Syllabus: Mathematics
Major (MJ) – 15

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title: **Laplace Transform**
Third (Higher-Level Courses) Semester - VI	**Study Materials** **Unit 1: Laplace Transforms** Laplace transform, Linearity, Existence theorem, Laplace transforms of elementary functions Laplace transforms of derivatives and integrals, shifting theorems, change of scale property, Laplace transforms of periodic functions, Dirac's delta function. (02 Questions **Unit 2: Further Properties of Laplace Transforms** Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives. (02 Questions) **Unit 3: Applications of Laplace Transform in the solution of ODE** Applications of Laplace transform into obtaining solutions of ordinary differential equations and integral equations. Applications of Laplace transform into obtaining solutions of boundary value Problems. (02 Questions) **Textbooks & References:** 1. Pankaj Kumar Manjhi (2019), *Integral Transforms, 1st Ed.,* Ayushman Publication House. 2. Charles K. Chui (1992). *An Introduction to Wavelets.* Academic Press. 3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.

FYUGP Syllabus: Mathematics
Major (MJ) – 16

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VII	**Metric Space** **Unit 1: (Basic Set Theory)** Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, Schröder-Bernstein theorem, Cantor's theorem, Order relation in cardinal numbers, Arithmetic of cardinal numbers, partially ordered set, Zorn's lemma and Axiom of choice, Various set theoretic paradoxes. (02 Questions) **Unit 2: (Metric Spaces)** Definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's intersection theorem. Subspaces. Compact metric spaces, Properties, Arzela-Ascoli Theorem and the Baire Category Theorem. (02 Questions) **Unit 3:** Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Compact Metric Spaces, its Properties, Arzela Ascoli theorem and Baire Category theorem. (02 Question) **Textbooks:** 5. G. F. Simmons: Introduction to Topology and Modern Analysis, McHill Publication. 6. S. Kumaresan: Topology of Metric Space, Narosa Publication.

FYUGP Syllabus: Mathematics
Major (MJ) – 17

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VII	**Complex Analysis** **Unit 1:** Geometry of complex numbers, regions in the complex plane, Limits and continuity of functions of complex variable, Derivatives, Necessary and sufficient conditions for differentiability. Analytic functions, examples of analytic functions, Cauchy-Riemann equations, exponential function, Logarithmic function, trigonometric function, derivatives of functions, bilinear transformation, cross ratio, conformal mapping. (02 Questions) **Unit 2:** Complex integration, Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra, Taylor's theorem, Maximum modulus principle, Schwarz lemma, Laurent's series. (02 Questions) **Unit 3:** Isolated singularities. Meromorphic functions. The argument principle, Rouche's theorem, Poles and Zeros. Fundamental theorem. Residues. Cauchy's residue theorem. Evaluation of integrals. (02 Question) **Textbooks:** 1. J.W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw-Hill Int. Edi. 2009. 2. S. Ponnusamy, Foundations of Complex analysis. 3. B. S. Tyagi: Functions of a Complex Variable, Kedar Nath Meerut.

FYUGP Syllabus: Mathematics
Major (MJ) – 18

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VII	<u>Advance Group Theory</u> **Unit 1:** Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties. (02 Questions) **Unit 2:** Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups. (02 Questions) **Unit 3:** Class equation and consequences, conjugacy in Sn, p-groups, Sylow's 1st, 2nd and 3rd theorems, Applications of Sylow's theorem. (02 Question) **Textbooks:** 1. D. S. Malik, J. M. Mordeson and M. K. Sen, Fundamentals of Abstract Algebra. 2. J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999. 3. M. Artin: Abstrat Algebra, Pearson Publication. 4. J. R. Durbin: Modern Algebra, Wiley Publication.

FYUGP Syllabus: Mathematics
Major (MJ) – 19

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VII	**Real Analysis - 3** **Unit 1:** **Riemann Integration:** Riemann integral, R-Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, first mean value theorem, second mean value theorem. **Riemann–Stieltjes integral:** Definition and existence of Riemann – Stieltjes integral, Conditions for R–S integrability, Properties of the R-S integral, R-S integrability of functions of a function, Integration and differentiation. (02 Questions) **Unit 2: (Improper integrals)** Convergence of improper integral at end points, point of infinite discontinuity, Comparison test, Dirichlet test and Abel's test for improper integrals. Convergence of Beta and Gamma functions. Test for uniform convergence of the integral of a product, Frullani integral. (02 Question) **Unit 3: (Uniform convergence)** Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability. (02 Questions) **Textbooks:** 4. K. A. Ross: Elementary Analysis, Springer. 5. G. Robert: Introduction to Real Analysis, Wiley Publication. 6. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002. 7. S. C. Malik, Savita Arora, Mathematical Analysis. 8. S. K. Mapa, Introduction to Real Analysis.

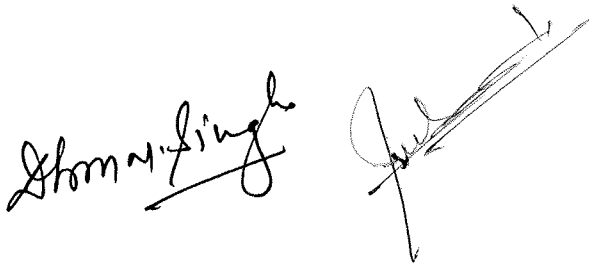
FYUGP Syllabus: Mathematics
Major (MJ) – 20

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VIII	**Differential Geometry & Tensor Calculus** **Unit 1:** Space curves - curvature and torsion. Serret-Frenet formula. Circular helix, the circle of curvature. Osculating sphere, Bertrand curves. Curves on a surface - parametric curves. Fundamental magnitude, curvature of normal section. Principal directions and principal curvatures, lines of curvature, Rodrigue's formula, Dupin's theorem, theorem of Euler, conjugate directions, and asymptotic lines. (03 Questions) **Unit 3:** One-parameter family of surfaces – Envelope, the edge of regression, developable associated with space curves. Geodesics - differential equation of geodesic, torsion of a geodesic. (02 Questions) **Unit 4:** Tensors, Tensor Algebra, Quotient theorem, Metric Tensor, Angle between two vectors. (01 Question) **Textbooks:**



FYUGP Syllabus: Mathematics
Major (MJ) – 21

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - V III	**Topology** **Unit 1:** Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods, Interior, exterior, and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topologies. (01 Question) **Unit 2:** First and second countable spaces. Lindelöf's theorem, separable spaces, second countability, and separability. Separation axioms to T_1, T_2, T_3, T_4: their characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem. Compactness, continuous functions and compact sets, conjugacy of functions, basic property of compactness, Heine-Borel Theorem, Compactness and finite intersection property, Product of spaces, Tychonoff's Theorem. (03 Question) **Unit 4:** Connected and disconnected spaces and their basic properties. Connectedness and product spaces. Connectedness and continuity, connectedness of $\mathbb{R}$, $\mathbb{R}^n$, and $\mathbb{C}^n$. Intermediate Value Theorem, Fixed Point Theorem. (02 Questions) **Textbooks:** 1. .

FYUGP Syllabus: Mathematics
Major (MJ) – 22

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - V III	**Special Functions** **Unit 1:** Introduction of generalized Hypergeometric function. Differential equation satisfied by pFq. Saalschutz's Theorem, Whipple's theorem, Dixon's theorem. Integrals involving generalized Hypergeometric function. Kummer's Theorem. Ramanujan's theorem. (02 Questions) **Unit 2:** Introduction of Hermite Polynomials. Recurrence relation. Orthogonal properties, expansion of polynomials generating function. Rodrigues formula for Hermite polynomials. Introduction of Laguerre polynomials. Recurrence relations, generating relating. Rodrigues formula and orthogonality. Laguerre's associated differential equation. More generating function. (02 Question) **Unit 3:** Introduction of Jacobi Polynomials generating function. Rodrigues formula and orthogonality. Introduction of Elliptic function and its properties. Jacobian theta function, zeros of theta function. (02 Questions) **Textbooks:** 1. . .

FYUGP Syllabus: Mathematics
Major (MJ) – 23

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Higher Level Courses) Semester - VIII	**Analytical Dynamics & Gravitation** **Unit 1:** Generalized coordinates Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation of conservative fields. (01 Question) **Unit 2:** Hamilton's variables, Hamilton canonical equations. Cyclic coordinates, Routh's equations, Jacobi-Poisson Theorem. Canonical transformation and generating function. Fundamental lemma of calculus of variations. Motivating problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachistochrone problem, Geodesic. Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations. (03 Question) **Unit 3:** Attraction and potential of a rod, Spherical shell, Laplace and Poison equations, Work done by shelf attracting systems, Equipotential system. (02 Question) **Textbooks:** 1.

FYUGP Syllabus: Mathematics
Minor (MN) – 01

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
First (Introductory Courses) Semester - I	**Matrices & Trigonometry** **Unit 1:** Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverseof a non-singular matrix through elementary row transformations, equivalence of matrices. (02 Questions) **Unit 2:** Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear and nonhomogeneous equations. Trigonometric or circular and hyperbolic function of complex variables together with their inverses, De Moivre's Theorem and its applications, Euler's theorem, the relation between trigonometric and hyperbolic function, the Exponential function of a complex variable, (02 Questions) **Unit 3:** Logarithms of a complex variable, Properties of the logarithmic function, Separation into real and imaginary parts. Gregory's series, Value of π by different series, Summation of Trigonometric series by C+iS method based on Arithmetic Progression, Geometric Progression, Logarithms and Binomial expansions, Summation of Trigonometric series by different methods. (02 Questions) **Textbooks:** 1. .

FYUGP Syllabus: Mathematics
Minor (MN) – 02

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Intermediate Level Courses) Semester - III	**Differential Calculus** **Unit 1:** Functions of one variable, Limit of a function (ε-δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of discontinuities, Differentiability of a function, Jacobians, maxima and minima of singe variable function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Successive Differentiation, nth Differentialcoefficient of functions, Leibnitz Theorem, Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions. (02 Questions) **Unit 2:** Geometrical meaning of tangent, Definition and equation of Tangent, Tangent at origin, Angle of intersection oftwo curves, Definition and equation of Normal, Cartesian sub tangent and subnormal, Tangents and normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar sub tangent and polar subnormal, Derivatives of arc (Cartesian and polar formula). (02 Questions) **Unit 3:** Curvature, Radius of curvature, Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes, existence and classification of singular points, points of inflection. (02 Questions) **Textbooks:** 1. .

FYUGP Syllabus: Mathematics
Minor (MN) – 03

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Third (Higher Level Courses) Semester - V	**Integral Calculus** **Unit – 1:** Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation, and integration under the integral sign. (02 Questions) **Unit – 2:** Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions. (01 Questions) **Unit – 3:** Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Drichlet's theorem and its Liovelle's extension. Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution. (03 Questions) **Textbooks:** 2. . .

FYUGP Syllabus: Mathematics
Minor (MN) – 04

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Advance Courses) Semester - VII	**Vector Analysis** **Unit –1:** Triple product, Reciprocal vectors, Product of four vectors, General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes. (02 Questions) **Unit –2:** Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates. (02 Questions) **Unit –3:** Ordinary differentiation of vectors, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl. Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem. (02 Questions) **Textbooks:** 1.

FYUGP Syllabus: Mathematics
Minor from Vocational - 01

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
First (Introductory Courses) Semester - II	**Probability and Statistics** **Unit 1: Probability** Introduction, Events & Different Types of Events, Addition & Multiplication Law, Conditional Probability, Bay's Theorem, Random Variables, Probability Function, Binomial Poison & Normal Distribution. (02 Questions) **Unit 2: Statistics** Definition, Function & Scope of Statistics, Arithmetic Mean, Weighted A.M., Median, Mode, Geometric & Harmonic Mean, and Their Merits & Demerits. Range, The Interquartile Range or Quartile Deviation, Average (Mean), Deviation Standard Deviation, Coefficient of Variation, Skew ness, Moments &Kurtosis. (02 Questions) **Unit 3: Correlation & Regression Analysis** Introduction, Karl Pearson's Coefficient of Correlation, Rank Correlation Coefficient. Difference Between Correlation & Regression, Regression Lines, Regression Equations, Regressions Coefficient. (02 Question) **Textbooks:** 1. S.P. Gupta & M.P. Gupta, "Business Statistics", Sultan Chand & Sons. 2. S.C. Gupta & V.K. Kapoor, "Fundamental of Mathematical Statistics", Sultan Chand & Sons.

FYUGP Syllabus: Mathematics
Minor from Vocational -02

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Second (Intermediate Level Courses) Semester - IV	**Optimization Techniques** **Unit 1: Linear Programming- Applications and Model Formulation** Introduction, Structure of Linear Programming Model, Advantages of Using Linear Programming, Limitations of Linear Programming, Applications Areas of Linear Programming, General Mathematical Model of Linear Programming Model, Guidelines on Linear Programming Model Formulation, Examples of LP Model Formulation. Introduction, Important Definitions, Graphical Solution Methods of LP Problem. (02 Questions) **Unit 2: Linear Programming- The Simplex Method** Introduction, Standard Form of an LP Problem, Simplex Algorithm (Maximization Case), Simplex Algorithm (Minimization Case). (02 Questions) **Unit 3: Transportation & Assignment Problem** Introduction, Mathematical Model of Transportation Problem, The Transportation Algorithm, Methods for Finding Initial Solution. Introduction, Mathematical Model of Statement Assignment Problem, Solution Methods of Assignment Problem. (02 Questions) **Text Book:** 1. J.K Sharma- Operations Research Theory & Applications, 3rd Edn, Macmillan India Ltd., New Delhi-2007. **Reference Book:** 1. H.A. Taha-Operations Research: An Introduction, Pearson Education, New Delhi, 2006.

FYUGP Syllabus: Mathematics
Minor from Vocational - 03

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Third (Higher Level Courses) Semester - VI	**Numerical Methods** **Unit 1: Solution of Algebraic and Transcendental Equations** Introduction, Bisection method, Iteration method, Method of False Position, Newton-Raphson method, Graeffe's Root-Squaring method. (02 Questions) **Unit 2: Interpolation** Introduction, Errors in Polynomial Interpolation, Finite Differences, Backward and Central, Detection of errors using Difference tables, Differences of a Polynomial, Newton's formulae for Interpolation, Central Difference Interpolation Formulae- Gauss's Central Difference Formula, Stirling's and Bessel's Formulae, Interpolation with unevenly spaced points, Lagrange's Interpolation Formula, Divided Differences and their properties- Newton's General Interpolation Formula, Inverse Interpolation. (02 Questions) **Unit 3: Numerical Differentiation and Integration** Introduction, Numerical Differentiation and Errors, Numerical Integration – Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Weddle's Rule, Romberg Integration, Newton- Cotes Integration Formulae. (02 Questions) **Text Book:** 1. S. S. Sastry -Introductory methods of Numerical Analysis, 4th Edition,Prentice Hall of India, New Delhi, 2006 **Reference Books:** 1. V. N. Vedamurthy et. al.-Numerical Methods, Vikas Publishing House, New Delhi, 2005. 2. B. S. Grewal- Numerical Methods in Engineering & Science, Khanna Publishers, Delhi,2005..

FYUGP Syllabus: Mathematics
Minor from Vocational - 04

Mid Semester Exam: Full Marks – 25. (Pass Maks – 10) End Semester Exam: Full Marks – 75. (Pass Marks – 30)	Credits - 04 No. of Lecturer - 60

General Instructions

There will be two groups of questions. Group – A will be compulsory and contain two questions, Question No. 1. contains very short answer type five questions throughout the Syllabus of 01 mark each whereas Question No. 2. contains two questions throughout the Syllabus of five marks each. Group – B will contain descriptive answer type six questions of fifteen marks each, out of which four are to be answered.

Year/ Semester	Paper Title & Study Materials
Fourth (Advance Courses) Semester - VIII	**Algebra** **Unit 1: Abstract Algebra** Group, General properties of groups, Subgroups, properties of subgroups, Ring, Integral Domain, Field. (03 Questions **Unit 2: Linear Algebra** Spaces and Subspaces, Basic and Dimension of Vector Spaces, Linear Transformation, Their Nullity and Rank. (02 Questions) **Unit 3: Matrix Algebra** Elementary Transformation, Inverse of a Matrix by Row Operation, Rank, Solution of a System of Linear Simultaneous Equation by Matrix Methods, Eigen Values, and Eigen Vectors, Quadratic Forms. (02 Questions) **TEXTBOOKS:** 1. Modern Algebra By A. R. Vasishtha. Krishna Prakashan Media (P) Ltd Meerut. 2. "Matrices" By A. R. Vasishtha. Krishna Prakashan Media (P) Ltd Meerut. 3. "Analytical Geometry of The Dimensions" By Dasguta Prasad, Bharti Bhawan 4. "Advanced Course in Modern Algebra" By Prof Dr.K.K.Jha, New Bharat Prakashan Delhi- 6. 5. "Krishna Series" Analytical Geometry of three Dimension" By A. R. Vasishtha. Krishna Prakashan Media (P) Ltd Meerut.