RKDF UNIVERSITY

RANCHI

SYLLABUS

BACHELOR OF SCIENCE

(MATHEMATICS HONS.)

NEP 2020

2023 Onwards

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

SEMESTER I

Subject Code	Paper Name	Credit
MJ01MAT	**ALGEBRA -I & CALCULUS -I**	4

Course Objectives Learning Outcomes:

This course will enable the students to:

1. Learn to solve system of linear equations.

- Solve the system of homogeneous and non homogeneous linear of m equations in n variables by using concept of rank of matrix, finding eigen values and eigenvectors.
- Sketch curves in Cartesian, polar and pedal equations.
- Students will be familiar with the techniques of integration and differentiation of function with real variables.
- Identify and apply the intermediate value theorems and L'Hospital rule.

Unit-I: Matrix: Recapitulation of Symmetric and Skew Symmetric matrices, Algebra of Matrices; Row and column reduction to Echelon form. Rank of a matrix; Inverse of a matrix by elementary operations; Solution of system of linear equations; Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. Eigen values and Eigen vectors of square matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof), real symmetric matrices and their properties, reduction of such matrices to diagonal form.

Unit-II: Curvature, Asymptotes and Curve Tracing Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

Unit-III: Differential Calculus-I: Limits, Continuity, Differentiability and properties. Properties of continuous functions. Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms and evaluation of limits usingL'Hospitalrule.

Unit-IV: Successive Differentiation: n th Derivatives of Standard functions $e\ ax{+}b$, $(ax + b)$ n , $\log(ax + b)$, $\sin(ax + b)$, $\cos(ax + b)$, $e\ ax\ \sin(bx + c)$, $e\ ax\ \cos(bx + c)$, Leibnitz theorem and its applications.Tracing of curves (standard curves).

Reference Books:

1. University Algebra - N.S. Gopala Krishnan, New Age International (P)Limited, 2015
2. Theory of Matrices - B S Vatsa, New Age International Publishers, 2010.
3. Matrices - A R Vasista, Krishna Prakashana Mandir, 2014.
4. Differential Calculus - Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
5. Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd.,2019.
6. Calculus – Lipman Bers, Holt, Rinehart &Winston, 1969.
7. Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I &II, 2009.
8. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc.Graw, 2008.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

SEMESTER II

Subject Code	Paper Name	Credit
MJ02MAT	**Algebra - II and Calculus – II**	4

Course Objectives and Learning Outcomes: This course will enable the students to

- Recognize the mathematical objects called Groups.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Explain the significance of the notions of Cosets, normal subgroups and factor groups
- Understand the concept of differentiation and fundamental theorems in differentiation and various rules.
- Find the extreme values of functions of two variables

Unit-I: Groups-I: Definition of a group with examples and properties, congruence, problems. Subgroups, center of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Lagrange's theorem and its consequences. Fermat's theorem and Euler's ϕ function.

Unit-II: Groups-II: Normal subgroups-Examples and problems, Quotient group, Homomorphism and isomorphism of groups, Kernel and Image of a homomorphism, Normality of the kernel, Fundamental theorem of homomorphism, Properties related to isomorphism, Permutation group, Cayley's theorem.

Unit-III: Partial Derivatives: Functions of two or more variables-explicit and implicit functions, partial derivatives. Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and illustrative examples. Taylor's and Maclaurin's series for functions of two variables, Maxima- Minima of functions of two variables.

Unit-IV: Integral Calculus: Recapitulation of definite integrals and its properties. Line integral: Definition of line integral and basic properties, examples on evaluation of line integrals. Double integral: Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. Triple integral: Definition of triple integrals and evaluation-change of variables, volume as triple integral .

Reference Books:

1. Topics in Algebra, I N Herstein, Wiley Eastern Ltd., NewDelhi, 2006.
2. Higher algebra, Bernard & Child, Arihant, 2016.
3. Modern Algebra, Sharma and Vasista, Krishna Prakashan Mandir, Meerut,U.P,1960.
4. Differential Calculus, Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
5. Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt.Ltd., 2015.
6. Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw Hill.,2008.
7. Mathematical Analysis, S C Malik, WileyEastern, 1
8. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas Publications, 2018.
9. Text Book of B.Sc. Mathematics, G K Ranganath, S Chand &Company, 2011

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ0MAT	**ORDINARY AND PARTIAL MECHANICS**	4

Course Objectives and Learning Outcomes :

- Learn various techniques of getting exact solutions of solvable first order differential equations andlinear differential equations of higher order.
- Know Picard's method of obtaining successive approximations of solutions of first order differentialequations, passing through a given point in the plane.
- Grasp the concept of a general solution of a linear differential equation of an arbitrary order and alsolearn a few methods to obtain the general solution of such equations.
- Apply a range of techniques to solve first & second order partial differential equations.
- Model physical phenomena using partial differential equations such as the heat and wave equations

COURSE CONTENT

Unit-I: First Order Differential Equations

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations andthe statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

Unit-II: Second Order Linear Differential Equations

Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters andmethod of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

Unit-III: First Order Partial Differential Equations

Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method .

Unit-IV: Second Order Partial Differential Equations with Constant Coefficients : Classification of linear partial differential equations of second order, Homogeneous and nonhomogeneous equations with constant coefficients.

Unit-V: Second Order Partial Differential Equations with Variable Coefficients: Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables

Reference Books:

1. Daniel A. Murray (2003). Introductory Course in Differential Equations, Orient.
2. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary DifferentialEquations (2nd edition). Narosa.
3. Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.
4. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
5. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.
6. Differential Equations – M D Raisinghania .

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

SEMESTER III

Subject Code	Paper Name	Credit
MJ04MAT	**REAL ANALYSIS**	4

Course Objectives and Learning Outcomes :

This course will enable the students

- To Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions
  from $\mathbb{R}$ to a subset of $\mathbb{R}$.
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence .
- Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute
  convergence of an infinite series of real numbers.
- Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.

COURSE CONTENT

Unit-I: Real Number System

Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$,The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$, Connected subsets of $\mathbb{R}$, Cantor set and Cantor function .

Unit-II: Sequences of Real Numbers

Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone Weierstrass theorem for sequences, Monotone convergence theorem, Subsequences, Bolzano sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence,Cauchy's convergence criterion.

Unit-III: Infinite Series

Convergence and divergence of infinite series of positive real numbers, Necessary condition

for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence, Rearrangement of series and Riemann's theorem.

Unit-IV: Riemann Integration

Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems.

Unit-V: Uniform convergence of sequence and series of functions

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,

Unit-VI: Convergence of Improper integrals

Convergence of improper integrals, comparison tests, absolute convergence, Abel's and Dirichlet's tests. Frullani's Integrals. Definition & convergence of Beta & Gamma functions and their properties, duplication formula, inter-relation. Evaluation of double and triple integrals. Multiple Integrals of Dirichlet's form, Liouville's extension. Change of order of integration and change of variables.

Reference Books:

1. Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition). WileyIndia.
2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition),Jones and Bartlett India Pvt. Ltd.
3. K. A. Ross (2013). Elementary Analysis: The Theory of Calculus (2nd edition). Springer.
4. Shanti Narayan & M. D. Raisinghania. Elements of Real Analysis

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ05MAT	**MECHANICS**	4

Course Objectives and Learning Outcomes:

This course will enable the students to:

- Familiarize with subject matter, which has been the single centre, to which were drawn mathematicians, physicists, astronomers, and engineers together.
- Understand necessary conditions for the equilibrium of particles acted upon by various forces and learnthe principle of virtual work for a system of coplanar forces acting on a rigid body.
- Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.
- Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
- Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

Course Content:

Unit-I: Statics

Equilibrium of a particle, Equilibrium of a system of particles, Necessary conditions of equilibrium, Moment of a force about a point, Moment of a force about a line, Couples, Moment of a couple, Equipollent system of forces, Work and potential energy, Principle of virtual work for a system of coplanar forces acting on a particle or at different points of a rigid body, Forces which can be omittedin forming the equations of virtual work.

Unit-II: Centres of Gravity

Centers of gravity of plane area including a uniform thin straight rod, triangle, circular arc, semicircular area and quadrant of a circle, Centre of gravity of a plane area bounded by a curve, Centre of gravity of a volume of revolution; Flexible strings,

Unit-III Common Catenary

Common Catenary, Intrinsic and Cartesian equations of the common catenary, Approximations of thecatenary.

Unit-IV: Rectilinear Motion

Simple harmonic motion (SHM) and its geometrical representation, SHM under elastic forces, Motion under inverse square law, Motion in resisting media, Concept of terminal velocity, Motion of varyingmass.

Unit-V: Motion in a Plane

Kinematics and kinetics of the motion, Expressions for velocity and acceleration in Cartesian, polar and intrinsic coordinates; Motion in a vertical circle, projectiles in a vertical plane and cycloidal motion.

Unit-VI: Central Orbits

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation of the orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetarymotion

Reference Books:

1. S. L. Loney (2006). An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies. ReadBooks.
2. P. L. Srivatava (1964). Elementary Dynamics. Ram Narin Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). Principles of Mechanics. McGraw-Hill.
4. S. Ramsey (2009). Statics. Cambridge University Press.
5. S. Ramsey (2009). Dynamics. Cambridge University Press.
6. R. S. Varma (1962). A Text Book of Statics. Pothishala Pvt. Ltd.

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

SEMESTER IV

Subject Code	Paper Name	Credit
MJ06MAT	**ABSTRACT ALGEBRA**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Recognize the mathematical objects called groups.
2. Link the fundamental concepts of groups and symmetries of geometrical objects.
3. Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.
6. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integraldomains, and fields.
7. Learn about polynomial rings, fundamental properties of finite field extensions, and classification offinite fields

Course Content:

Unit-I: Groups and Subgroups

Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups. Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem

Unit-II: Normal Subgroups & Permutation Groups

Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups. Cycle notation for permutations, Properties of permutations, Even andodd permutations, alternating groups, Cayley's theorem and it applic applications.

Unit-III: Group Homomorphisms

Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of

isomorphisms; First, second and third isomorphism theorems for groups.

Unit-IV Rings and Fields

Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between integral domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.

Unit-V: Polynomial Rings

Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain.

Unit-VI: Field Extensions and Finite Fields

Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field,Classification of finite fields.

Reference Books:

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition).Cambridge University Press.
3. David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.
4. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
5. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
6. N. S. Gopalakrishnan (1986). University Algebra, New Age International Publishers.
7. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
8. Thomas W. Hungerford (2004). Algebra (8th edition). Springer.
9. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
10. Serge Lang (2002). Algebra (3rd edition). Springer-Verlag.
11. S. Luthar & I. B. S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
    S. Luthar & I. B. S. Passi (2012). Algebra: Volume 2: Rings. Narosa.

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ07MAT	**LINEAR ALGEBRA**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Recognize consistent and inconsistent systems of linear equations by the row echelon form of theaugmented matrix, using rank.
2. Find eigenvalues and corresponding eigenvectors for a square matrix.
3. Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.
6. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integraldomains, and fields.
7. Learn about polynomial rings, fundamental properties of finite field extensions, and classification offinite fields.

Course Content:

Unit-I: Row Echelon Form of Matrices and Applications

Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices; Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and theCayley□Hamilton theorem.

Unit-II: Vector Spaces

Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, Linearlyindependent and dependent sets, Bases and dimension.

Unit-III: Linear Transformations

Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Changeof coordinates, Rank and nullity of a linear transformation and rank-nullity theorem.

Unit-IV: Further Properties of Linear Transformations

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.

Unit-V: Inner Product Spaces

Inner product spaces and orthogonality, Cauchy□Schwarz inequality, Gram□Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Unit-VI: Adjoint of a Linear Transformation and Canonical Forms

Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

Reference Books:

1. Bernard Kolman & David R. Hill (2003). Introductory Linear Algebra with Applications (7th edition).Pearson Education Pvt. Ltd. India.
2. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). Linear Algebra and its Applications (5thedition). Pearson Education Pvt. Ltd. India
3. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). Linear Algebra (4thedition).Prentice-Hall of India Pvt. Ltd.
4. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
5. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications. UGC DOCUMENT ON LOCFMATHEMATICS 30
6. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
7. Serge Lang (2005). Introduction to Linear Algebra (2nd edition). Springer India.
8. Vivek Sahai & Vikas Bist (2013). Linear Algebra (2nd Edition). Narosa Publishing House.
9. Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition). Elsevier

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ08MAT	**COMPLEX ANALYSIS & METRIC SPACE**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Visualize complex numbers as points of ℝ2 and stereographic projection of complex plane on theRiemann sphere.
2. Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy□Riemann equations.
3. Learn the role of Cauchy□Goursat theorem and Cauchy integral formula in evaluation of contourintegrals.
4. Understand several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano□Weierstrass property, compactness, and connectedness.
5. Identify the continuity of a function defined on metric spaces and homeomorphisms.

Course Content:

Unit-I: Complex Plane and functions.

Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere; Complex functions and their limits including limit at infinity; Continuity, Linear fractional transformations andtheir geometrical properties.

Unit-II: Analytic Functions and Cauchy □ Riemann Equations

Differentiability of a complex valued function, Cauchy□Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions; Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions.

Unit-III: Conformal representation

Transformation, Jacobian, conformal transformation, some general transformations, bilinear transformation. critical points, fixed points, cross ratio, preservance of cross ratio, fixed points of bilinear transformation.

Unit-IV: Concepts in Metric Spaces

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

Unit-V: Complete Metric Spaces and Continuous Functions

Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Unit-VI: Compactness

Compact spaces, Sequential compactness, Bolzano□Weierstrass property, Compactness and finite intersection property, Heine□Borel theorem, Totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.

Reference Books:

1. Lars V. Ahlfors (2017). Complex Analysis (3rd edition). McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010). Complex Analysis (3rd edition). Springer.
3. James Ward Brown & Ruel V. Churchill (2009). Complex Variables and Applications (9th edition).McGraw-Hill Education.
4. E. T. Copson (1988). Metric Spaces. Cambridge University Press.
5. Satish Shirali & Harikishan L. Vasudeva (2006). Metric Spaces. Springer-Verlag.
6. Micheál O'Searcoid (2009). Metric Spaces. Springer-Verlag.
7. 7 .G. F. Simmons (2004). Introduction to Topology and Modern Analysis. McGraw-Hill.

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

SEMESTER IV

Subject Code	Paper Name	Credit
MJ09MAT	**NUMERICAL ANALYSIS**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Obtain numerical solutions of algebraic and transcendental equations.
2. Find numerical solutions of system of linear equations and check the accuracy of the solutions.
3. Learn about various interpolating and extrapolating methods.
4. Solve initial and boundary value problems in differential equations using numerical methods.
5. Apply various numerical methods in real life problems.

Course Content:

Unit-I: Numerical Methods for Solving Algebraic and Transcendental Equations

Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton'smethod and secant method for solving equations.

Unit-II: Numerical Methods for Solving Linear Systems

Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tridiagonal systems; Gauss□Jacobi, Gauss□Seidel and successive over-relaxation (SOR) methods.

Unit-III: Interpolation

Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation,Finite difference operators, Gregory□Newton forward and backward difference interpolations.

Unit-IV: Numerical Differentiation

First order and higher order approximation for first derivative, Approximation for second derivative;Derivative using forward, backward and central difference interpolation formulae.

Unit-V: Numerical Integration

General quadrature formula, Trapezoidal rule, Simpson's rules and error analysis, BulirschStoer extrapolation methods, Richardson extrapolation, Weddle's rule, Newton-Cote's method. Solution of ordinary differential equations: Picard's method of successive approximations .

Unit-VI: Initial and Boundary Value Problems of Differential Equations

Euler's method, Runge□Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

Reference Books:

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education,India.
3. F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.

   M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and EngineeringComputation (6th edition). New Age International Publishers.

Subject Code	Paper Name	Credit
MJ10MAT	**LINEAR PROGRAMMING**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Analyze and solve linear programming models of real life situations.
2. Provide graphical solutions of linear programming problems with two variables, and illustrate theconcept of convex set and extreme points.
3. Understand the theory of the simplex method.
4. Know about the relationships between the primal and dual problems, and to understand sensitivityanalysis.
5. Learn about the applications to transportation, assignment and two-person zero-sum game problems.

Course Content:

Unit-I: Linear Programming Problem, Convexity and Basic Feasible Solutions

Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets, Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit-II: Simplex Method

Optimality criterion, Improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method.

Unit-III: Utility

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit-IV: Sensitivity Analysis

Changes in the cost vector, right-hand side vector and the constraint matrix of the linear programmingproblem.

Unit-V: Applications to Transportation & Assignment Problems

Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method.

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and NetworkFlows (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.
5. Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory(3rd edition). Wiley India Pvt. Ltd.

Subject Code	Paper Name	Credit
MJ11MAT	**NUMBER THEORY**	4

UNIT I

Divisibility and primes, H.C.F., Euclid's Algorithm, unique factorization, perfect numbers. Residue class, complete and reduced residue system, congruences and their properties, Fermat's theorem, Wilson's theorem.

UNIT II

Arithmetical functions, Euler's and Mobius function, Mobius inversion formula. , system of linear Algebraic Congruence, solution by inspection, Solution of system of congruences, Chinese remainder theorem.

UNIT III

The Diophantine equations, Farey sequence, continued fractions, Pell's equation.

Reference books

1. Burton, D.M., Elementary Number Theory, 7th Edition. McGraw-Hill Education, 2010.
2. Hardy, G.H. and Wright, E.M., An introduction to the Theory of Numbers, 4th Edition. Oxford University Press, 1975.
3. Niven, I., Zuckerman, H.S. and Montgomery, H.L., Introduction to Theory of Numbers, 5th Edition. John Wiley & Sons, 1991.
4. Koblitz N., A Course in Number Theory and Cryptography, Graduate Texts in Mathematics, No.114.
5. New-York: Springer-Verlag, 1987.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

SEMESTER VI

Subject Code	Paper Name	Credit
MJ12MAT	**GENERAL TOPOLOGY**	4

Course objectives and outcomes: This course will enable the students to

- **TO learn about notation of topological space**
- **To learn about convergence sequence in a topological space.**
- **To learn about connected and disconnected sets.**

UNIT-I

Notion of a topological space, open set topology and fundamental concepts of open sets, closed sets, neighbourhoods, adherent points, accumulation points, closure, interior and boundary in a topological space, subspace. Important interrelations between fundamental concepts.

UNIT-II

Convergence of sequences in a topological space, continuity and homomorphism, characterisations of continuity and homeomorphism, base and sub base of a topology, continuity and sequential continuity.

UNIT-III

Separation axioms in a topological space**, T0, T1, T2, Regular find normal** space and their mutual implication relationships, unique limit of sequencesin a Hansdorff (T2) space. Hereditary and topological properties.

UNIT-IV

Connected and disconnected spaces, connectedness and continuity, characterizations of connected and disconnected spaces, connected sets in atopological space, sufficient conditions under which connected sets is connected, connected sets in R (under usual topology).

Reference Books:

1. Prof. R. Shukla – General Topology, Macmillan Company of India Ltd.

2. W.J. Pervin – Foundations of General Topology, Academic Press, London.
3. J.L. Kelley – General Topology, Affiliated East-West Press Pvt. Ltd., New Delhi.
4. Prof. K.K. Jha – Advanced General Topology, Nav Bharat Prakashan, Delhi-6.
5. G.F.Simmons – Introduction to General Topology and Modern Analysis, McGrawHill Book Company, INC.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ13MAT	**MEASURE THEORY**	4

Course objectives and outcomes: This course will enable the students to

- **To learn about** lebesgue measurable sets
- **To learn about Borel sets and its** characterization
- **To learn about** integral properties of Riemann

UNIT-I

Lebesgue Measurable sets and their properties, Measurable functions, Lebesque outer measure

UNIT-II

Borel sets and their measurability, Characterization of measurable sets, Non-measurable sets.

UNIT-III

Lebesgue integral, Riemann integral properties of Lebesgue integral for Bounded Measurables functions.

UNIT-IV

Convergence theorem in Lebesgue integral theory, Lebesgue's monotone convergence theorem, Lebesgue's dominated convergence theorem, Fatou's theorem, Fatou- Lebesgue theorem.

UNIT-V

Function of Bounded variation, Lebesgue differentiation theorem, Differentiation of an integral, Differentiation and integration.

REFERENCE BOOKS:

1. Dr. K. K. Jha, Advanced course in Real Analysis and higher analysis MacmallanCompany Ltd. India.
2. P. R. Halmos - Measure Theory.
3. P.K. Jain & V.P. Gupta – Lebasgue Measure and integration. New Age International (p) Limited, New Delhi.
4. H, L, Royden – Real Analysis.

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
MJ14MAT	**AXIOMATIC SET THEORY**	4

Course objectives and outcomes: This course will enable the students to

- **To learn about Cantor's theory of sets**
- **To learn about** formal language set theory
- **To learn about ZFS-system of theory of sets and resolution of paradoxes.**

UNIT-I

Study of various paradoxes of Cantor's theory of sets, Russel's paradox, Paradox of grounded sets, Paradox of non-circular sets, Burali Forti paradox, Cardinal paradox.

UNIT-II

Ordinal paradox, Richard's paradox, Russel's vicious circle principle and zig - zag theory and some of their draw backs, Formal language for axiomatising set theory.

Unit-III

Axioms for ZFS-system of theory of sets and resolution of paradoxes, modifications in the definition of naïve set theoretic concepts.

UNIT-IV

Construction of natural numbers theorem of recursion and arithmetic of natural numbers.

UNIT-V

Zorn's lemma and principle axiom of choice, Von Neumann's theory of cardinal and ordinal numbers and their properties.

REFERENCE BOOKS:

1. R. Shukla – Lectures on set theory – Pothishata Pvt. Ltd. Allahabad
2. 2. Dr. K. K. Jha - Advanced Set Theory and the foundations of mathematics - P. C.Dwadash shreni and company Pvt Ltd., Aligarh.
3. P. R. Halmos - Naive Ser Theory - D. Van Nostrand Company INC, New York.
4. Suppes P. - Axiomatic Set Theory - D. Van Nostrand Company, New York.
5. Bernays P. - Axiomatic set theory - North Holland, Amsterdam.

Subject Code	Paper Name	Credit
MJ15MAT	**INTEGRATION THEORY**	4

UNIT-I

Signed measure, Hahn decomposition theorem, Mutually singular measures.

UNIT-II

Radon - Nikodym theorem, Lebesgue decomposition, Reisz representation theorem, Extension theorem (Cartheodory).

UNIT-III

Lebesgue - Stieltjes integral, Product measures, Fubini's theorem, Differentiation and integration.

UNIT-IV

Decomposition into absolutely continuous parts, Bair sets, Baire measure, Continuous functions with compact support.

UNIT-V

Regularity of measure on locally compact spaces. Integration of continuous functions with compact support. Riesz Markoff theorem.

REFERENCE BOOKS:

1. H. L. Royden - Real Analysis, Mecmillan Publishing Co. INC
2. S. K. Berberian - Measure and Integration, Chelsea Pub. Co.N.Y.
3. Inder K. Rana – An Introduction to Measure and Integration, Narosa Pub.House, Delhi.
4. Serge Lang, Analysis I and II, Addison - Wisley Pub. Corpor, Inc. 1967.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

SEMESTER VII

Subject Code	Paper Name	Credit
MJ16MAT	**PROGAMMING IN C**	3

Unit 1: Introduction

1.1. Problem Solving Using Algorithm

1.2. Problem Solving Using Flowchart

1.3. Introduction of Programming Language

1.4. Introduction to C Language

1.5. C Programming Environment

Unit 2: Variables and Operators

2.1. C character set & Keywords

2.2. Constants, Variables & Data Types

2.3. Operator and their types

2.4. Expression and their evaluation

2.5. Type conversion in expressions

2.6. Operator precedence & associativity

Unit 3: Branching & Looping

3.1. If statement

3.2. If-else statement

3.3. switch-case statement

3.4. While Loop

3.5. Do-while loop

3.6. For Loop

Unit 4: Array & Function

4.1. One Dimensional Array

4.2. Two Dimensional Array

4.3. Introduction to Function

4.4. Types of Function (Recursive & Non-Recursive).

Unit 5: Pointer and User Defined Data Types

5.1. Introduction to pointer

5.2. Pointer & Arrays

5.3. Pointer & Function

5.4. Structure

5.5. Union

Reference Books:

1. K.R. Venugopal – Mastering C, Tata McGraw Hill
2. Yashwant Kanetkar – Let us C, BPB Publication
3. E.Balagurusamy – Programming in ANSI C, Tata McGraw Hill.

Subject Code	Paper Name	Credit
MJL16MAT	**PROGAMMING IN C**	1

Application of Ms- Dos. Windows 95, 2000, Ms- word 97, Excel 97 for writing letters, preparing prints, Level, preparing report, Graph and preparing chart.

Fox Pro (Interactive).

Recommended books:

1. Visual Fox Pro – Susan : L. Reber and Robert Nicholas Kulik.
2. Advanced Ms Dos – Ray Duncan

Subject Code	Paper Name	Credit
MJ17MAT	**ADVANCED FUNCTIONAL ANALYSIS**	4

UNIT-I

Definition and examples of topological Vector Spaces. Convex, balanced and absorbing sets and their properties. Minkowski's functional, Subspace, product spaces and quotient spaces of a topological vector space.

UNIT-II

Locally convex topological Vector spaces, Normable and metrizable topological vector spaces. Complete topological vector spaces and Frechet space.

UNIT-III

Linear transformation and linear functionals and their continuity. Finite - dimensional topological vector spaces. Linear Verieties and Hyperplanes. Geometric form of Hahn-Banach theorem.

UNIT-IV

Uniform- boundedness principles. Open mapping theorem and closed graph theorem for Frehet spaces. Banach – Alaoglu theorem. Extreme points and External sets. Krein- milman's theorem. Duality, Polar, Bipolar theorem. Baralled and Bornological Spaces.

REFERENCES BOOKS

1. John Horvath, Topological Vector Space and Distributions. Addison – Wesley Publishing Company, 1966.
2. J. L. Kelley and Issac Namioka. Linear Topology Spaces. D. Van Nostand Company, Inc., 1963.
3. You - Chuen Wong, Introductory Theory of Topology Vector Spaces, Marcel Dekker, Inc., 1992.
4. Laurent Schwarz, Functional Analysis, Courant Institute of Mathematical Sciences, New York University, 1964
5. F. Treves, Topological Vector Spaces, Distributions, and Kernel, Academic Press, Inc., New York, 1967.

Subject Code	Paper Name	Credit
MJ18MAT	**THEORY OF DIFFERENTIAL EQUATIONS**	4

UNIT-I

Initial value problem and the equivalent integral equation. mth order equationin d-dimensions as a first order system.

UNIT-II

Concept of local existence, existence and uniqueness theorem with examples.

UNIT-III

Ascoli-Arzela theorem. A theorem on convergence of solutions of a family of initial value problems.

UNIT-IV

Picard- Lindel theorem. Peano's existence theorem. Maximal intervals of existence. Extension theorem. Kamke's convergence theorem.

UNIT-V

Gronwall's inequality. Maximal and minimal solutions. Differential inequalities. A theorem of Winter. Uniqueness theorems.

REFERENCE BOOKS:

1. W.I. Reid – ordinary differential equations. John Wiley and sons.
2. E.A. Coddington – Theory of ordinary differential equations and N. Levinson, McGraw Hill, New York, 1957.
3. P. Hartman – Ordinary differential equations, John Willey, 1964.

Subject Code	Paper Name	Credit
MJ19MAT	**GRAPH THEORY**	4

UNIT-I

Definition and examples of graphs, and their basic properties, paths, circuits, subgraphs, operation on graphs, degree of vertex, out degree and in degree**.**

UNIT-II

Walks, paths, circuits, connected graphs, disconnected graphs and components, Eulerian and Hamiltonian graphs.

UNIT-III

Trees and their properties, Pendant vertices in a tree, distance and centers in a tree.

UNIT-IV

Planar graphs, Kuratowskis two graphs, Euler's formula.

REFERENCE BOOKS:

1. N. Deo- Graph Theory with application to engineering and Computer Science.

SEMESTER VIII

Subject Code	Paper Name	Credit
MJ20MAT	**MATHEMATICAL TRANSFORMS**	4

UNIT I

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ordinary differential equations (ODEs) and partial differential equations (PDEs).

UNIT II

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

UNIT III

Z-Transform: Z–transform and inverse Z-transform of elementary functions, Shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations.

Reference books:

1. I. N. Sneddon, Fourier Transforms, Dover.
2. Joel L. Schiff, The Laplace Transform: Theory and Applications (Undergraduate Texts in Mathematics), Springer.
3. E. Kreyszig, “Advanced Engineering Mathematics”, 10th Edition, John & Wiley Sons, U.K., 2016.
4. Ronald N. Bracewell,“The Fourier Transforms and its Applications”, 3rd Edition, McGraw Hill Science,1999.
5. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS.

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

Subject Code	Paper Name	Credit
AMJ01MAT	**ADVANCE MECHANICS**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.
2. Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.
3. Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed.
4. Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.
5. Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Course Content:

Unit-I: Statics in Space

Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Nul points,lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.

Unit-II: Motion of a Rigid Body

Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body, Euler's equations of motion

for a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates, Motion about a fixed axis, Compound pendulum.

Unit-III: Kinematics of Fluid Motion

Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, Boundary surface

Unit-IV: Kinds of Fluid Motions

Streamlines and pathlines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines.

Unit-V: Kinetics of Fluid Motion

Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli'sequation, Impulsive motion.

Unit-VI: Motion in Two-Dimensions

Stream function, Complex potential, Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle, Milne□Thomson circle theorem.

Reference Books:

1. S. Ramsay (1960). A Treatise on Hydromechanics, Part-II Hydrodynamics. G. Bell & Sons.
2. F. Chorlton (1967). A Textbook of Fluid Dynamics. CBS Publishers.
3. Michel Rieutord (2015). Fluid Dynamics An Introduction. Springer.
4. A. Milne (1965). Vectorial Mechanics, Methuen & Co. Limited. London

Subject Code	Paper Name	Credit
AMJ02MAT	**PROBABILITY & STATISTICS**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Understand distributions in the study of the joint behaviour of two random variables.
2. Establish a formulation helping to predict one variable in terms of the other that is, correlation and linearregression.
3. Understand central limit theorem, which establish the remarkable fact that the empirical frequencies ofso many natural populations, exhibit a bell shaped curve.

Course Content:

Unit-I: 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.

Unit-II: 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; Normalapproximation to the binomial distribution.

Unit-III: Bivariate Distribution

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.

Unit-IV: Sampling and Estimation Theory

Sampling Theory, Random samples and Random numbers, Sampling with and without Replacement, Sampling distribution of Means, Proportions, differences and Sums, Unbiased Estimates, Efficient estimates, Point and Interval estimates, Confidence-interval estimates of population parameters

Unit-V: Correlation, Regression and Central Limit Theorem

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.

Reference Books:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). Introduction to Mathematical Statistics(7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications(8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). Probability, Springer-Verlag.
4. Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier.
5. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company.Distributed by Hindustan Publishing Corporation (India) Delhi.

Subject Code	Paper Name	Credit
AMJ03MAT	**DISCRETE MATHEMATICS**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Know the notion of mathematical logic.
2. Learn about partially ordered sets, lattices and their types.
3. Understand Boolean algebra and Boolean functions, logic gates, switching circuits and theirapplications.
4. Solve real-life problems using finite-state and Turing machines.

Course Content:

Unit-I: Mathematical Logic

Statements, Truth Tables, Conditional and Biconditional statements, Tautologies and contradictions, Equivalent statements, Principle of duality, Quantifiers

Unit-II: Partially Ordered Sets

Definitions, examples and basic properties of partially ordered sets (poset), Order isomorphism, Hasse diagrams, Dual of a poset, Duality principle, Maximal and minimal elements, Least upper bound and greatest upper bound, Building new poset, Maps between posets.

Unit-III: Lattices

Lattices as posets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, examples and properties of modular and distributive lattices; Complemented, relatively complemented and sectionally complemented lattices.

Unit-IV: Boolean Algebras and Switching Circuits

Boolean algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive and conjunctive normal forms, Minimal

forms of Boolean polynomials, Quine□McCluskey method, Karnaugh diagrams, Switching circuits and applications.

Reference Books:

1. B. A. Davey & H. A. Priestley (2002). Introduction to Lattices and Order (2nd edition). CambridgeUniversity Press.
2. Edgar G. Goodaire & Michael M. Parmenter (2018). Discrete Mathematics with Graph Theory (3rdedition). Pearson Education.
3. Rudolf Lidl & Günter Pilz (1998). Applied Abstract Algebra (2nd edition). Springer.
4. Kenneth H. Rosen (2012). Discrete Mathematics and its Applications: With Combinatorics and GraphTheory (7th edition). McGraw-Hill.
5. C. L. Liu (1985). Elements of Discrete Mathematics (2nd edition). McGraw-Hill.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

Subject Code	Subject title	Credit
RC01	**RESEARCH METHODOLOGY**	4

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process

2. Problem Identification & Formulation - Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis. Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.

3. Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

4. Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

5. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurementNominal, Ordinal, Interval, Ratio.

6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the samplePractical considerations in sampling and sample size.

7. Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chisquare test including testing hypothesis of association.

8. Interpretation of Data and Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

10.**Use of tools I techniques for Research**: methods to search required information effectively, Reference Management Software like Zotero/ Mendeley, Software for paper formatting like LaTeX/ MS Office, Software for detection of Plagiarism

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

Subject Code	Subject title	Credit
RC02	**RESEARCH PROPOSAL**	4

Process of writing a research proposal

That includes the following points :

1. TITLE.
2. INTRODUCTION
3. REVIEW OF LITERATURE (BACKGROUND AND RATIONALE)
4. RESEARCH QUESTION(S) ..
5. AIMS & OBJECTIVES
6. RESEARCH METHODOLOGY.
7. PLAN OF WORK
8. REFERENCE/BIBLIOGRAPHY.

Subject Code	Subject title	Credit
RC03	**Research Report**	4

A research report is a reliable source to recount details about a conducted research. It is most often considered to be a true testimony of all the work done to garner specificities of research. Research reports present the results of formal investigations into the properties, behavior, structures, and principles of material and conceptual entities. Almost any physical phenomenon or concept may be investigated in a research framework. The following are some key differences between formal research, and other less structured kinds of inquiry.

1. ***Problem definition***: the rigorous reduction of the inquiry to a narrow question with a quantifiable answer. The most significant preliminary phase of research writing is that of effective problem definition. This process is one of identifying an interesting question and narrowing the research inquiry to a manageable size.
2. ***Research approach***: the structuring of the research according to a methodology associated with a specialized field of inquiry. Specialized fields have research methodologies that are followed in investigating problems. These range from general methods of interviewing and literature researching to highly specialized procedures for using materials and mechanical devices to establish appropriate conditions for generating data. Adapting a sound research methodology to the investigation of your problem is a major milestone in the conduct of your inquiry.

Research report: the presentation of the research and its results in a rigorously formatted document that follows a conventional structure. In presenting your research, you pull all its elements together into a focused, coherent document. Research reports contain a standard set of elements that include.

RKDF UNIVERSITY RANCHI

Bachelor of Science (Mathematics Hons.)

MINOR

SEMESTER I/ III/ V/ VII

SEMESTER I

Subject Code	Paper Name	Credit
MN01MAT	**DIFFERENTIAL, INTEGRAL & VECTOR CALCULUS**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

- Expand different functions in series form
- Handle partial differentiations and related geometry
- Evaluate maxima & minima of function of two variables
- Integrate rational and irrational functions and definite integrals
- Understand differentiation and integration under the sign of integration
- Familiarize with curve tracing and to calculate related area and volume.
- Evaluate Gradient, Divergence & Curl

Course Content:

UNIT 1: Differential calculus

Leibnitz's Theorem. Taylor's and Macularuins's series expansions of functions. Applications of Taylors's and Maclaurins' Series. Tangent and Normal, (Cartesian, Parametric form), Angle betweentwo Curves. Length of tangent, Normal, Sub Tangent, Subnormal in Cartesian Forms. Partial Differention: Eulers' Theorem, Curvature. Asymptotes. Maxima and Minima of functions of two variables

UNIT 2: Integral Calculus

Integration by Transformation, Integration by Substitution, Integration by Parts. Evaluation of Definite Integrals, Reduction Formulae, Curve Tracing, Length and Area, Surface Area and Volumeof Solids of Revolution

UNIT 3: Vector Calculus

Differentiation of a vector function. Derivatives of a sum of vectors, Derivatives of a product of vectors (both Scalar and Vector Products). Gradient, Divergence and Curl and Second Order Vector Differential Operators in Cartesian coordinates systems.

Reference Books:

1. Differential Calculus: A Das Gupta & S B Prasad.
2. Differential Calculus: Lalji Prasad
3. Integral Calculus: Dasgupta& Prasad.
4. Integral Calculus: Lalji Prasad
5. Vector Calculus: Dasgupta & Prasad
6. Vector Calculus: Lalji Prasad

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

SEMESTER III

Subject Code	Paper Name	Credit
MN03MAT	**GEOMETRY, GROUP THEORY, DIFFERENTIAL EQUATION**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Reduce the general equation of second degree to the standard forms
2. Know the polar equation of the conic
3. Learn the first order ordinary and partial Mechanics and methods of their solutions
4. Recognize and handle mathematical objects called group
5. Analyze concept of Lagrange's theorem.

Course Content:

UNIT 1: Co-ordinate Geometry

Transformation of General Equation of the Second Degree. Conditions for General Equation of Second Degree to Represent a Parabola, Ellipse and Hyperbola. Equations of the Tangent and Normal to a Curve via calculus. Polar Equation.

UNIT 2: Mechanics

Differential Equations of First Order and Higher Degree, Clairaut's Form, Singular Solution, Orthogonal Trajectories. Linear Equation with Constant Co-efficient, Homogenous Linear Equation with variable coefficients. Simultaneous equations.

$\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ and Total Differential Equations $Pdx + Qdy + Rdz = 0$ together with Geometric Significance.

UNIT 3: Group Theory

Binary Operations, Notion of Group, Abelian Group and Non-Abelian group with Examples. Uniqueness of Identity element and Inverse elements in a group, Different ways of Defining a Group,Concept of Subgroup and Cyclic Group, Cosets, Lagrange's Theorem

Reference Books:

1. Coordinate Geometry: A Das Gupta
2. Coordinate Geometry: Lalji Prasad
3. Abstract algebra: A R Vashishtha
4. Modern Algebra: Lalji Prasad
5. Differential Equations: MD Raisinghania

RKDF UNIVERSITY RANCHI
Bachelor of Science (Mathematics Hons.)

SEMESTER V

Subject Code	Paper Name	Credit
MN05MAT	**REAL ANALYSIS, COMPLEX ANALYSIS, MATRICES**	4

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Understand the notion of bounds in the subset of real numbers
2. Recognize the sequence & series of real numbers and their convergence
3. Be familiar with the concept of Analyticity of the function of complex variables
4. Calculate simultaneous and iterated limits
5. Understand operations and types of Matrices and to calculate their eigenvalues and eigenvectors

Course Content:

UNIT 1: Real Analysis

Sequence: Definition, Bounds, Limit of a sequence, Monotonic Sequence and their convergence, Algebraic Operations and Limit, Cauchy Sequence, General Principle of Convergence of a sequence.

Series: Definitions, Convergent Series, Divergent Series, Pringsheim's Theorem, Comparison tests, Cauchy's Root Test, D'Alembert's Ratio Test, Alternating Series and Leibnitz Test, Absolutely Convergent Series.

UNIT 2: Complex Analysis

Real Functions of Two Variables: Simultaneous and Iterated limits: Continuity, Partial Derivatives, Differentiability and related Necessary and Sufficient conditions. Functions of Complex variables Limit, Continuity, Derivative, Cauchy – Reimann Equations, Analytic Function, Harmonic function

UNIT 3: Matrices

Definitions, Operations on Matrices, Matrix Algebra, Type of Matrices, Transpose, Adjoint andInverse of a matrix, Solution of system of linear equations. Eigen Values & Eigen Vectors

Reference Books:

1. Real Analysis, Shanti Narayan & M D Raisinghania
2. Real Analysis: Lalji Prasad.
3. Complex Variables: J N Sharma.
4. Matrices: A. R. Vasishtha

SEMESTER VII

Subject Code	Paper Name	Credit
MN07COM	GROUP THEORY-I	4

UNIT-I

Definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

UNIT-II

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

UNIT-III

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.

UNIT-IV

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra,4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups,4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS.

****