KOLHAN UNIVERSITY, CHAIBASA
JHARKHAND

Syllabus for FYUGP (Mathematics Major & Minor)

As per

Revised Curriculum and Credit Frame work of NEP- 2020

To be effective from academic session 2022-26

University Department of Mathematics
Kolhan University, Chaibasa
West Singhbhum, Jharkhand-833202

UNIVERSITY DEPARTMENT OF MATHEMATICS
KOLHAN UNIVERSITY, CHAIBASA

Four-Year under Graduate Programme (FYUGP)

As per Provisions of NEP-2020 to be implemented from Academic Year 2022-23

COMPOSITION OF BOARD OF STUDIES

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Program: **Certificate** Class: **UG**	Year: **First**	Semester: **I**
Subject: **Mathematics**		
Course Code: **MJ-1**	Course Title: **Calculus**	

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

a) Apply the rules of differentiation, including the chain rule, to compute derivatives of functions. Also, able to apply different mean value theorems, such as Rolle's theorem and Lagrange's mean value theorem, to establish results about the behavior of differentiable functions.

b) Approximate functions using Maclaurin's and Taylor's series, analyze the error of these approximations using Taylor's theorem with Lagrange, Cauchy, and Roche-Schlomilch forms of remainder, and use these results to find extrema of functions.

c) Define and compute the curvature of a curve at a given point, and understand its geometric significance and identify the different types of asymptotes of general algebraic curves, including parallel asymptotes, asymptotes parallel to axes, and slant asymptotes.

d) Trace Cartesian, polar, and parametric curves and identify their key features, as well as use calculus techniques to analyze the behavior of curves and solve real-world problems that involve curve tracing.

e) Derive and apply reduction formulae, parameterize curves, and compute arc length, area of bounded curves, volume, and surface area of surfaces of revolution.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Differential calculus:** Differentiability of a real valued function, Geometrical interpretation of differentiability, Rules of differentiation, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems, Successive differentiation, Leibnitz's theorem.	15 h
II	**Expansions of Functions:** Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder, Maxima and minima.	12 h
III	**Curvature and Asymptotes:** 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.	13 h
IV	**Curve Tracing:** Tracing of Cartesian, polar and parametric curves; Envelope and evolutes.	10 h
V	**Integral Calculus:** Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sin^n x \cos^m x\,dx$ and $\int \cos^m x . \cos nx\,dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, Area of bounded curve, volume and area of surface of revolution.	10 h

Sessional Internal Assessment (SIA) Full Marks – 25 Marks
A – Internal written Examination – 20 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. R. K. Dwivedi, Calculus, 1st Edition, Pragati Prakashan, Meerut, India (2019).
2. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley India.

Program: **Certificate** Class: **UG**	Year: **First**	Semester: **II**
Subject: **Mathematics**		
Course Code: **MJ-2**	Course Title: **Matrices**	

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

a) Understand and apply fundamental concepts in number theory, including well ordering property, division algorithm, congruence relations, mathematical Induction, and the fundamental theorem of arithmetic.

b) Gain a thorough understanding of matrices, including types of matrices, determinants, operations, invertibility, matrix rank, normal forms, and the rank-nullity theorem

c) Gain a strong grasp of systems of linear equations, including their matrix form, augmented matrices, consistency (both necessary and sufficient conditions), and methods for solving homogeneous and non-homogeneous linear equations.

d) Find eigenvalues and corresponding eigenvectors for a square matrix.

Credit: **4 (Theory)**	**Compulsory**	
Full Marks: **75**	Time: **3 Hours**	**Hours**

Unit	Content	Hours
I	Theory of numbers: Well-ordering property (WOP) of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, Fundamental Theorem of Arithmetic.	15 h
II	Matrices: Matrices and types of matrices, determinants, operations on matrices, submatrix, block Matrix, Invertible Matrices, Uniqueness of Inverse Matrix, Rank of a matrix, Normal form PAQ, Canonical or Echelon form, Rank-Nullity Theorem of a Matrix.	15 h
III	System of linear equations: Matrix form of system of linear equations, augmented matrix, consistent and inconsistent system of linear equations, necessary and sufficient condition consistency of a system of linear equations, method of solving of homogeneous and non-homogeneous linear equations.	15 h
IV	Eigen values and Eigen vectors of matrices: Characteristic polynomial of a matrix, Eigen values and Eigen vectors, A.M. and G.M. of Eigen values, Theorems on Eigen values and Eigen vectors, Minimal Polynomial, Cayley-Hamilton theorem.	15 h

Sessional Internal Assessment (SIA) Full Marks – 25 Marks
A – Internal written Examination – 20 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. David M. Burton (2007). Elementary Number Theory (7th edition). McGraw-Hill
2. Vasishtha A. R., Vasishtha A. K. (2011). Matrices. Krishna's Prakashan Media (P) Ltd
3. Bernard Kolman & David R. Hill (2003). Introductory Linear Algebra with Applications (7th edition). Pearson Education Pvt. Ltd. India.
4. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). Linear Algebra and its Applications (5th edition), Pearson Education Pvt. Ltd. India.
5. Pankaj Kumar Manjhi (2018). Algebra. (1st edition) Pragati Prakashan, Meerut

Program: **Certificate** Class: **UG**	Year: **First**	Semester: **II**
Subject: **Mathematics**		
Course Code: **MJ-3**	Course Title: **Anal tic Geometry and Trigonometry**	

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

a) Develop skills in two-dimensional nalytical geometry, including transformations of rectangular axes, reduction of general equations to normal form, analysis of conic systems, and understanding the polar equation of conics.

b) Gain proficiency in three-dimensional analytical geometry, including the concepts of direction cosines, straight lines, pla s, spheres, intersecting spheres, spheres passing through a given circle, cones, and cylinders.

c) Gain the ability to analyze and classif onicoids, understand their plane sections, determine generating lines, reduce equations to no mal form, and classify quadrics.

d) Develop concepts in trigonometry, including the polar form of complex numbers, DeMoivre's theorem, and its applications in trigono etric function expansions.

e) Develop proficiency in working with perbolic and exponential functions, understanding their properties and applications.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Analytical geometry of two dim sions:** Transformation of rectangular axes, General equation of second degree and its reduction to normal form, Systems of conies, Polar equation of a conic.	15 h
II	**Analytical geometry of three dimensions:** Direction cosines, Straight line, Plane, Sphere, Two Intersecting Spheres, Spheres Through a Given Circle Cone, Cylinder.	15 h
III	**Conicoid:** Central conicoids, paraboloids, plane sections of conicoids, Generating lines. Reduction of se nd-degree equations to normal form; classification of quadrics.	15 h
IV	**Trigonometry:** Polar form of complex number, nth roots of unity, De-Moivre's Theorem, Applic ons of De-Moivre's Theorem in expansions trigonometric functi n, Hyperbolic function, Exponential Function and their properties.	15 h

Sessional Internal Assessment (SIA) Full Marks – 25 Marks
A – Internal written Examination – 20 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. Loney, S. L., Elements of Coordinate Geometry.
2. Shanti Narayan, Analytical Geometry   Three Dimensions.
3. Bell, R- J. T., Elementary Treatise on Coordinate Geometry.
4. Chaki, M. C, A Textbook of Analytical Geometry, Calcutta Publishers.
5. Chakraborty, J. G., and Ghosh, P. R., Advanced Analytical Dynamics.
6. Titu Andreescu, & Dorin Andrica (201 ... Complex Numbers from A to...Z. (2nd edition). Birkhauser.
7. James Ward Brown and Ruel V. Churc ill, Complex Variables and Applications, 8th Ed., McGraw — Hill Internation l Edition. Mfg)

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **III**
Subject: **Mathematics**		
Course Code: **MJ-4**	Course Title: **Real Analysis**	

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

a) Understand many properties of the real line ℝ and learn to define sequence in terms of functions from ℝ to a subset of ℝ.

b) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

c) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

d) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Real Number System** Axioms in ℝ, Absolute value of a real number; Bounds of a sets, Supremum and infimum of a nonempty subset of ℝ, The completeness property of ℝ, Archimedean property, Definition and types of intervals, Neighborhood of a point in ℝ, Open, closed and perfect sets in ℝ	**15 h**
II	**Sequences of Real Numbers:** Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, 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 first theorem on limit, Cauchy's convergence criterion. Completeness property of set of real number.	**15 h**
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, Raabe's test, Logarithmic test, Cauchy's condensation Test, De Morgan & Bertrand's test, Higher logarithmic test, Gauss's test, Cauchy's root test, Integral test;	**20 h**
IV	**Alternating series**: Alternating series, Leibniz test, Absolute and conditional convergence. Properties of absolutely convergent series.	**10 h**

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr)
B . Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Real Analysis: Dasgupta & Prasad
2. Real Analysis: Lalji Prasad
3. Real Analysis: K.K. Jha
4. Principle of Real Analysis: S. C. Malik

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **III**
Subject: **Mathematics**		
Course Code: **MJ-5**	Course Title: **Vectors**	

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

a) Understand the concepts of scalar & vector products of three and four vectors.
b) Understand the concept of vector function of scalar variable t, Scalar point functions, vector point functions, Grad, Curl and Divergence.
c) Inter-relationship amongst the line integral, double and triple integral formulations
d) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Product of three & four vectors:** Product of 3 & 4 vectors, Reciprocal system of vectors, Lami's theorem. $\lambda - \mu$ theorem, work done, Moment of force. Couple.	**15 h**
II	**Vector Differentiation:** Vector function of scalar variable t, it's derivative and geometrical meaning. Derivative of product of two and three vectors	**15 h**
III	**Grad, Divergence & Curl:** Scalar point function and vector point function, grad, divergence and curl, their expansion formulae and properties.	**15 h**
IV	**Green's, Stoke's & Gauss's Divergence theorem:** Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. *Advanced Engineering Mathematics* (10th edition). Erwin Kreyszig, Wiley
2. Vector Analysis: Lalji Prasad, Paramount

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **IV**
Subject: **Mathematics**		
Course Code: **MJ-6**	Course Title: **Real Analysis & Set theory**	

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

a) Understand the concept of limit & continuity of a function.
b) Understand the concept of differentiation and expansion of function with remainder.
c) Understand the definition and condition for Riemann Integrability.
d) Understand the generalized set operations and relation on sets.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Limit and Continuity: Limit, Continuity, Discontinuities, uniform continuity, properties of functions continuous in closed intervals, Functions of bounded variation.	15 h
II	Derivability, Relationship with continuity, Taylor's theorem, Maclaurin's theorem, remainder after n terms, Power series expansion of $(1+x)^n$, sinx, cosx and log (1+x) using suitable remainder after n terms.	15 h
III	Riemann Integration Definition, Darboux's theorem I & II. Integrability condition, particular classes of bounded integerable function primitive, fundamental theorem, first and second Mean value theorem.	15 h
IV	Index family of sets, Generalised set operations & De-Morgan Laws, set Bijection mapping: Countable and Uncountable sets, Equivalence relation and related fundamental theorem on partition. Partial order & Total order relation	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks
A . Internal written Examination . 20 Marks (1 Hr)
B . Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Real Analysis by Lalji Prasad
2. Real Analysis by K. K. Jha
3. Principle of Real Analysis: S. C. Malik

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **IV**
Subject: **Mathematics**		
Course Code: **MJ-7**	Course Title: **Ordinary Differential Equation**	

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

a) solve ordinary differential equation of first order and understand its physical significance.
b) solve higher order differential equation using concept of complimentary function & particular integral.
c) solve ordinary differential equation with variable coefficients.
d) solve simultaneous & total differential equation and understand its geometrical significance.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	First order higher degree ordinary differential equations, Equation solvable for y, solvable for x, Clairaut's form, singular solution orthogonal trajectories.	15 h
II	Linear Differential Equation of higher order with constant coefficients. Homogeneous linear differential equation (Cauchy- Euler's Form)	15 h
III	Second order linear differential equations: Normal forms (removal of first derivative) solution by changing independent variable and by variation of parameters.	15 h
IV	Simultaneous equation dx/P = dy/Q = dz/R and Total differential equation Pdx+Qdy+Rdz=0 together with their geometrical significance.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr)
B Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Differential Equation by Lalji Prasad
2. Advanced differential equation by M. D. Raisinghania
3. Differential equation by J. N. Sharma

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **IV**
Subject: **Mathematics**		
Course Code: **MJ-8**	Course Title: **Group Theory**	

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

a) Understand concept of groups & their properties.
b) Understand the concept of subgroups and cyclic groups.
c) Understand the concept of Factor group, centralizer and normalizer of group.
d) Understand the concept of Homomorphism in Group & Isomorphism and related properties.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	**Content**	**Hours**
I	Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups.	**15 h**
II	Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Classification of subgroups of cyclic groups, Order of group, Lagrange's theorem,	**15 h**
III	Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups,	**15 h**
IV	Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; Fundamental theorem of homomorphism. Cayley's theorem and its applications.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Modern Algebra: Surjeet Singh Quazi Zameeruddin
2. Modern Algebra: A R Vasistha
3. Topics in Algebra: I. N. Herstein
4. A First Course in Abstract Algebra: J. B. Fraleigh

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **V**
Subject: **Mathematics**		
Course Code: **MJ-9**	Course Title: **Mechanics**	

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

a) Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.

b) Understand the concept of friction and laws of friction. Student will be able to solve problems related to friction.

c) Deal with the kinematics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.

d) Understand concept work and energy and related laws.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Reduction of system of coplanar forces, equation of resultant. Condition for equilibrium, astatic centre. 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 omitted in forming the equations of virtual work.	15 h
II	Laws, Angles and cone of friction, equilibrium on a rough inclined plane, particle constrained to move on a rough curve under any given forces.	15 h
III	Kinematics in two dimensions: tangential, normal, radial, transverse velocities and acceleration. Angular Velocity and acceleration. Rectilinear motion and simple pendulum: S.H.M., compounding of two S.H.M., Repulsive motion, motion under inverse square law.	15 h
IV	Rectilinear Motion (Kinetics): Newton's Law, work, KE, work Energy principle, impulse, Torque and angular momentum, conservation of energy, momentum and angular momentum, Hooke's law. Extension of an elastic string: horizontal & vertical case.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr)

B Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Mechanics: Singh & Sen
2. *Statics and Dynamics*. A. R. Vashishtha Krishna.
3. Statics. S. Ramsey Cambridge University Press.
4. Dynamics. S. Ramsey Cambridge University Press.

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **V**
Subject: **Mathematics**		
Course Code: **MJ-10**	Course Title: **Theory of Equation & Higher Arithmetic**	

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

a) solve polynomial equation using relation of roots and coefficients
b) solve cubic equation by Cardon's method.
c) understand the concept of congruences and their properties.
d) solve simultaneous linear congruences.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Relations of root and their symmetric functions with coefficients. Transformation of equations, Descarte's rule of signs.	15 h
II	Cardon's solution of a cubic equation, Descarte's solution of a bi-quadratic equation, Discriminant and nature of roots.	15 h
III	Divisibility, H.C.F. Primes & Unique factorization in N & Z the Diophantine equation ax+by=c. Residue class, complete and reduced residue system, congruences and their properties, Fermat's theorem, Euler's theorem, and Wilson's theorem.	15 h
IV	Algebraic congruences, Solution by inspection. Solution of $ax \equiv b \ (mod\ m)$, Chinese remainder theorem, non-linear algebraic congruency with respect to the modulus.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr.)
B Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Theory of equation: Lalji Prasad
2. Theory of Equation – Burnside & Penton
3. Basic Number theory : S. B. Malik
4. Introduction to Number Theory : Niven & Zukerman

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **V**
Subject: **Mathematics**		
Course Code: **MJ-11**	Course Title: **Complex Analysis**	

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

a) apply the concept of continuity & differentiability of function of two variables.
b) apply the concept of analytic function & form analytic function.
c) understand standard transformations.
d) understand the concept of conformal mapping.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	**Content**	**Hours**
I	Real Functions for two variables. Simultaneous and iterated limits; continuity, partial derivatives, differentiability, and related necessary and sufficient conditions.	**15 h**
II	Functions of a complex variables: Limit, continuity, derivative Cauchy Riemann Equations analytic function, harmonic function, construction of analytic function Miln Thompson Method.	**15 h**
III	Geometric Importance of some standard transformations e.g. $w = z + c$ w=cz $w = 1/z$, $w = (az + b) / (cz + d)$ $(bilinear)$.	**15 h**
IV	Conformal transformation as transformation effected by analytic functions special conformal transformations $w=z^2$, $w=e^z$, w=sinz	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Complex Analysis by Lalji Prasad
2. Complex Analysis by J. N. Sharma

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **VI**
Subject: **Mathematics**		
Course Code: **MJ-12**	Course Title: **Dynamics & Statics**	

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

a) apply the condition for equilibrium in problems.
b) solve problems related to common catenary.
c) solve problems related to gravitation % Newton's laws of motion.
d) solve problems related to projectile.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Conditions for equilibrium of forces in three dimensions. Wrench pitch, Null Lines.	15 h
II	Common Catenary, Stable equilibrium, energy test of stability (problems involving one variable only).	15 h
III	Motion of a particle under a central force, Differential equation of a central orbit in both polar and pedal co-ordinates. Newton's law of gravitation, planetary orbits, Kepler's laws of motion.	15 h
IV	Motion of projectile under gravity in a non-resisting medium. Motion of the mass centre and motion relative to the mass centre D'Alembert's principle. Two-dimensional motion of a rigid body rotating about a fixed axis, compound pendulum.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr.)
B Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Dynamics Part I & II A. S. Ramsay
2. Dynamics by P.P. Gupta, Sanjay Gupta
3. Statics by Loney
4. Statics by A. R. Vasistha

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **VI**
Subject: **Mathematics**		
Course Code: **MJ-13**	Course Title: **LPP & Statistics**	

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

a) solve problems related to linear programming problems.

b) solve problems related to transportation & assignment problems.

c) study the nature of curve, fit a suitable curve for bivariate data.

d) study correlation and do regression analysis.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	**Content**	**Hours**
I	Convex sets in R2 and their properties, L.P.P., problem formulation, Graphical Method. Simplex method including Big M-method, Duality: Dual Simplex method.	**15 h**
II	Transportation and Assignment. Deterministic replacement models, sequencing problems on two machines and n jobs.	**15 h**
III	Measures of Skewness and Kurtosis. Curve fitting and method of least square.	**15 h**
IV	Correlation and regression & their expectations and variance.	**15 h**

Sessional Internal Assessment (SIA) Full Marks - 25 Marks

A Internal written Examination - 20 Marks (1 Hr.)

B Over All Performance including Regularity - 05 Marks

Books Recommended:

1. Linear Programming Problem: R.K. Gupta
2. Linear Programming Problem: Lalji Prasad
3. Operations Research: S. D. Sharma
4. Mathematical Statistics: Kapur & Saxena

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **VI**
Subject: **Mathematics**		
Course Code: **MJ-14**	Course Title: **Analysis II & Ring**	

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

a) test the convergence of improper integral.
b) solve multiple integrals using theorems like Green's theorem, Stokes theorem.
c) understand the concept of ring and Ideals.
d) explain the concept of field & homeomorphism.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Convergence of improper integrals, Comparison Tests, Absolute convergence, Able's and Dirichlet's Tests. Frullani's Integrals, Def. Duplication formula, inter-relation.	15 h
II	Multiple Integrals via Dirichlet's Theorem Liouville's extension. Change of order of integration and change of variables. Vector Integration: Line Integral, Surface Integral, Green's theorem in R2, Stoke's theorem, Gauss divergence theorem.	15 h
III	Rings, Preliminary Results, Special Kinds, subrings and Ideals. Quotient rings.	15 h
IV	Fields and Homomorphism. Field for quotient and embedding theorem, polynomial rings, Euclidian ring & Unique factorization in it.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Mathematical Analysis: Shanti Narayan
2. Mathematical Analysis: Mallick Arora
3. Integral Calculus: Williamson
4. Vector Calculus: Shanti Narayan
5. Modern Algebra: A. R. Vasistha
6. Modern Algebra: Goyal & Gupta

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **VI**
Subject: **Mathematics**		
Course Code: **MJ-15**	Course Title: **Numerical Analysis & Programming in C**	

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

a) find roots of equation and interpolate by numerical methods.
b) differentiate % integrate by numerical methods.
c) know about the logics and algorithms needed for computer programming.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Solution of Equations: Bisection, regula-falsi, Newton's method, Root of Polynomials. Interpolation: Lagrange and Hermite Interpolation, divided differences Schemes, Interpolation Formula using Differences.	15 h
II	Numerical Differentiation: Numerical formulas. Numerical Integration Quadrature Formula Simpsons and Trapezoidal Rule.	15 h
III	Programmer's model of a computer. Algorithms. Flow Charts. Data Types. Arithmetic and input/output instructions. Decision control structures. Decisions statements.	15 h
IV	Logical and Conditional operators. Loop. Case control structures. Functions, Recursions, Preprocessors. Arrays, Puppeting of string. Structures. Pointers. File formatting.	15 h

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Programming in ANCI in C.E. Balaguru Swamy.
2. Numerical Analysis: J.B. Scarborough
3. Introduction to Numerical Analysis: A. Gupta & S.C. Bose

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VII**
Subject: **Mathematics**		
Course Code: **MJ-16**	Course Title: **Fluid Mechanics & Special Function**	

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

a) understand the nature of fluid, its pressure and centre of pressure.
b) explain the fluid motion using equation of continuity and Bernoulli's theorem.
c) find series solution of differential equations about ordinary and singular points.
d) understand the properties of Legendre polynomials and properties of Hypergeometric functions.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Nature and Properties of Fluid pressure, pressure of heavy liquids. Equilibrium of fluids under given system of forces. Centre of pressure.	15 h
II	Thrust on plane and curved surfaces. Lagarangian and Eulerian methods, Equation of continuity. Euler's equation of motion for perfect fluid, Bernoulli's Theorem.	15 h
III	Series solution: Ordinary point, singular point (regular), General Methods and forms of series solution (Indicial equation-frobenius method). [N.B. result of analysis regarding validity of series. Solution are to be taken for granted] Bessel's equation: Solution Recurrence formula for $J_n(x)$; generating function for $J_n(x)$, equations reducible to Bessel equation, Orthogonality of Bessel's functions.	15 h
IV	Legendre equation: Solution, Rodrigue's formula, Legendre polynomials, generating function for $P_n(x)$, Orthogonality of Legendre polynomials. Hypergeometric functions, special cases, Integral representation. Summation theorem.	15 h

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Hydrostatics: J.P. Sinha
2. Hydrodynamics: Ramsey / M.D. Raisingania
3. Advance differential equation: M. D. Raisinghania

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VII**
Subject: **Mathematics**		
Course Code: **MJ-17**	Course Title: **Metric space & Discrete Mathematics**	

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

a) Develop the concept of metric space and related properties.
b) Learn the idea of completeness of a space with its properties.
c) Learn the idea of continuous and uniform continuous functions.
d) Learn the concept of cardinality & mathematical induction.
e) understand the concept of graph and lattices.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Definition and example of metric spaces, Open sets, Interior closed Sets closure.	15 h
II	Convergence, completeness, Bair's theorem, Cantor's Intersection theorem. Continuous maps, Uniform Continuity, and related extensions.	15 h
III	Sets and Propositions-Cardinality. Mathematical Induction. Principle of Inclusion and exclusion. Relations and Functions – Binary Relations. Equivalence Relations and partitions. Partial. Order Relations and Lattices, chains and Antichains. Pigeon Hole Principle.	15 h
IV	Graphs and Planar Graph, basic terminology. Multigraphs. Weighted Graphs. Paths and Circuits. Shortest paths. Eulerian Paths and Circuits. Travelling Salesman Problem. Planer Graphs. Boolean Algebras – Lattices and algebraic structures. Duality. Distributive and complemented Lattices. Boolean lattices and Algebras. Boolean Functions and Expression.	15 h

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Discrete Mathematics: C.L. Lieu, Elements of Discrete Mathematics: McGraw Hill International Ed.
2. Topology: K.K. Jha / J.N. Sharma
3. Mathematical Analysis: Shanti Narayan / Mallick Arora
4. Metric Space by Lalji Prasad

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VII**
Subject: **Mathematics**		
Course Code: **MJ-18**	Course Title: **Integral Transform**	

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

a) learn concept of Laplace and inverse Laplace transform.
b) solve the differential equation using Laplace transform.
c) learn the concept and properties of Fourier transform.
d) learn application of Fourier sine & cosine transform.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Laplace transform: Def, transformation of elementary functions, properties, inverse transform, transform derivatives and integrals, multiplication by t^n division by t.	15 h
II	Inverse Laplace Transform, Convolution theorem and application to differential equation.	15 h
III	Infinite Fourier Transform: Infinite Fourier sine transform, Infinite Fourier cosine transform, Relation between Fourier & Laplace transform.	15 h
IV	The Finite Fourier Transform & Integral: Finite Fourier sine transform, Finite Fourier cosine transform, Fourier Integral.	15 h

Sessional Internal Assessment (SIA) Full Marks 25 Marks
A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Laplace's & Fourier Transforms J.K. Goyal, K.P. Gupta, G.S. Gupta
2. Integral Transform & Fourier Series: A. N. Srivastava

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VII**
Subject: **Mathematics**		
Course Code: **MJ-19**	Course Title: **Partial Differentiation**	

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

a) apply a range of techniques to solve first & second order partial differential equations.
b) apply Monge's method to solve non-linear equation of second order.
c) model physical phenomena using partial differential equations such as the heat and wave equations.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Partial differential equation, formation, linear p.d.e. of order 1-Lagrange's method.	15 h
II	Non-linear equation of order 1, four forms Charpits method, Jacobi Method. Homogeneous linear equation with constant co-efficient Rules of C.F. and P.I.	15 h
III	Non-linear equations of second order, Monge's method.	15 h
IV	Boundary Value Problem: Derivation and solution of one-dimensional wave equation and one-dimensional heat equation.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A Internal written Examination . 20 Marks (1 Hr.)
B Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Advanced Differential Equation: M.D. Raisingania
2. Differential equation: J.N. Sharma

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VIII**
Subject: **Mathematics**		
Course Code: **MJ-20**	Course Title: **Linear Algebra & Linear Difference equation**	

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

a) understand concept of basis of vector spaces and construct orthonormal basis.
b) understand the concept of rank & nullity.
c) construct difference equations and find its general solutions.
d) find solution of linear difference equations and homogeneous difference equations.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Vector Space: Def. & properties, subspaces, linear dependence, dimension and basis of a finite dimensional vector space, Quotient space, Direct sums and complements matrices and change of basis. Inner product & norm in a I. S., properties of inner product, Schwartz inequality, orthogonal set, orthogonal basis and Gram-schmidt construction for finite dimensional inner product space.	15 h
II	Linear transformation: Def, Sylvester Law of nullity, algebra of linear transformations, Dual spaces, principal of duality. Matrices and linear transformation, similar matrices, even matrices, diagonalisation Eigen root (Algebraic geometric and multiplicity).	15 h
III	Difference Equation Order, Solution of Difference Equation, Existence & Uniquencess theorem, solution of the form. $y_{n+1} = Ay_n + C$	15 h
IV	Linear Difference Equation with constant coefficient: Basic Definition. Combination of solution, Fundamental set of solution, Homogeneous Difference Equation & their solution (General & Particular), Special operator, variation of parameters.	15 h

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Modern Algebra: Surjeet Singh & Quazi Zameeruddin
2. Linear Difference Equation: R.K. Gupta & D.C. Agarwal.

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VIII**
Subject: **Mathematics**		
Course Code: **AMJ-1**	Course Title: **Topology**	

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

a) learn about the concept of compactness in metric space.
b) define topological space its bases and different types spaces.
c) learn different types of compactness in topological spaces.
d) learn different types separation axioms in topological spaces and also the connectedness of topological spaces

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	**Content**	**Hours**
I	Compactness in metric space, Ascoli's theorem. Topological spaces:	**15 h**
II	Definition, examples, base, sub-base, first axiom space, second axiom space, comparison of topologies.	**15 h**
III	Compactness: Compact space, Lindeloff space, product space, Tychonoff's theorem, locally compactness.	**15 h**
IV	Separation: T_1 – space, T_2 – space, normal & completely regular space, Uryshon's lemma, Tietze extension theorem, Uryshon's metrization theorem. Connectedness: connectedness & its properties.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Real Analysis: H. L. Royden, P. M. Fitzpatrick
2. Topology: J. N. Sharma, J. P. Chauhan
3. Advanced General Topology: K. K. Jha

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VIII**
Subject: **Mathematics**		
Course Code: **AMJ-2**	Course Title: **Complex Analysis II**	

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

a) apply complex integration in solving problems.
b) learn about power series expansion and their convergence.
c) apply method of contour integration.
d) learn about conformal mapping.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Integral: Cauchy's integral theorem, Cauchy's integral formula, Morera's theorem, Liouvillies theorem, Taylor's theorem, Laurent's theorem, Rouche's theorem, fundamental theorem of algebra.	15 h
II	Power series: formula for radius of convergence of power series, absolute & uniform convergence theorem of power series, uniqueness theorem of power series, term by term integration and differentiation theorem.	15 h
III	Residue & poles, contour integration and problems	15 h
IV	Conformal mapping: Conformal and bilinear mapping, necessary & sufficient condition for conformal mapping, mapping from half plane to circle, mapping from unit circle to unit circle and related problems.	15 h

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A . Internal written Examination . 20 Marks (1 Hr.)
B . Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Complex Variable: Churchill
2. Theory of Functions: Titch Marsh
3. Complex Analysis: J. B. Conway
4. Function of a Complex Variable: Goyal & Gupta

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VIII**
Subject: **Mathematics**		
Course Code: **AMJ-3**	Course Title: **Real Analysis & Measure Theory**	

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

a) learn the concept of uniform convergence in sequence & series of functions.
b) learn about Fourier series and its applications.
c) learn the concept of measure theory and its properties.
d) know about the measurable functions & its properties.

Credit: **4 (Theory)**	**Compulsory**	
Full Marks: **75**	Time: **3 Hours**	
Unit	**Content**	**Hours**
I	Sequence and series of function: Uniform convergence of sequence and series of real function. Cauchy's general principle of uniform convergence, continuity of the sum of a series of function. Weiestrass's M-test for uniform convergence. Term by term integration and differentiation.	**15 h**
II	Fourier series: Fourier series expansion of a function relative to an orthonormal system. Bessel's inequality, pointwise convergence of trigonometric Fourier series, Dirichlet's integral, Perseval's theorem, Riemann-Lebesgue theorem, Problems on finding trigonometric Fourier series representation of periodic functions.	**15 h**
III	Measure theory: Outer measure, measurable sets through Caratheodory approach, arithmetical properties of measurable sets, two fundamental theorems and examples of uncountable sets of zero measure.	**15 h**
IV	Measurable Functions: Closure of class of measurable function under all algebraic and limit operations, Littlewood's third principle trigonometric Fourier series representation of periodic functions. Function bounded over a set of finite measure, condition of measurability, Lebesgue integral and its arithmetical properties, comparison with R-integral, bounded convergence theorem.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr.)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Principle of Mathematical Analysis: Walter Rudin
2. Mathematical Analysis: Shanti Narayan
3. Real Analysis: H. L. Royden
4. Advanced Real Analysis: K. K. Jha
5. Measure theory: Gupta & Gupta

Minor Syllabus

Semester	Paper	Code	Course Title	Credit
I	Minor-1A	MN-1A	Calculus	4
II	Minor-2A	MN-2A	Discrete Mathematics	4
III	Minor-1B	MN-1B	Real Analysis	4
IV	Minor-2B	MN-2B	Discrete Mathematics-II	4
V	Minor-1C	MN-1C	Vectors	4
VI	Minor-2C	MN-2C	Probability Theory	4
VII	Minor-1D	MN-1D	Real Analysis-II	4
VIII	Minor-2D	MN-2D	Operations Research	4

Program: **Certificate** Class: **UG**	Year: **First**	Semester: **I**
Subject: **Mathematics**		
Course Code: **MN-1A**	Course Title: **Calculus**	

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

a) Understand the concept of functions, limits, and continuity, and apply them to solve mathematical problems.

b) Use differentiation rules, including the chain rule and mean value theorem, to differentiate real-valued functions and apply successive differentiation and Leibnitz's theorem to solve calculus problems.

c) Develop skills in finding antiderivatives, computing definite integrals using Riemann sums and the fundamental theorem of calculus, and using various integration techniques to solve real-world problems.

d) Gain proficiency in integrating various types of functions, analyzing curves, and calculating area and volume of surfaces of revolution using integration techniques.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Functions and Limits:** Definition of functions and their properties, Limits of functions and their properties, Continuity of functions.	12 h
II	**Differential calculus:** Differentiability of a real valued function, Geometrical interpretation of differentiability, Rules of differentiation, Chain rule of differentiation, Mean value theorem and its applications, Successive differentiation, Leibnitz's theorem.	18 h
III	**Integration**: Antiderivatives, Indefinite and definite integrals, Riemann sums and the definite integral, Fundamental theorem of calculus, Properties of definite integrals, Integration Techniques.	12 h
IV	**Integral Calculus:** Integration of rational and irrational functions, Reduction formula, Computing of definite integral, Curve tracing, Length of curve, Computing of double and triple integrals, Area and Volume of surface of revolution.	18 h

Sessional Internal Assessment (SIA) Full Marks – 25 Marks
A – Internal written Examination – 20 Marks (1 Hr)
B – Over All Performance including Regularity – 05 Marks

Books Recommended:

1. R. K. Dwivedi (2019). Calculus, 1st Edition, Pragati Prakashan, Meerut, India.
2. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley India.
3. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
4. Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
5. Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

Program: **Certificate** Class: **UG**	Year: **First**	Semester: **II**
Subject: **Mathematics**		
Course Code: **MN-2A**	Course Title: **Discrete Mathematics**	

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

a) Understand the concept equivalence relation & partial order relation.
b) Understand the concept of bounds in POSET and able to understand the concept of Lattice.
c) Understand mathematical logic and logical operations to various fields.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Relation:** Reflexive, Symmetric, Antisymmetric & transitive relation, Partition, Equivalence relation, Congruence Modulo Relation, Induced relation, Fundamental theorem.	**15 h**
II	**Partial Order Relation:** Partial Order Set, $l.u.b.$ & $g.l.b$, $inf.$, $sup.$, maximal & minimal element. Definition & examples of Lattice, Zorn's lemma	**15 h**
III	**Logic:** Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions, and precedence of logical operators.	**15 h**
IV	**Propositional equivalence:** Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. Validity of argument by different methods.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Set theory by K. K. Jha,
2. R. P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education,
3. Discrete Mathematics by M. K. Gupta; Krishna Prakashan.
4. Discrete Mathematics by Lipschutz, Lipson & Patil; Schaum's Outlines

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **III**
Subject: **Mathematics**		
Course Code: **MN-1B**	Course Title: **Real Analysis**	

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

a) 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 $\mathbb{R}$.

b) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

c) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

d) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.

Credit: **4 (Theory)**	**Compulsory**	
Full Marks: **75**	Time: **3 Hours**	**Hours**

Unit	Content	Hours
I	**Real Number System** Axioms in $\mathbb{R}$, Absolute value of a real number; Bounds of a sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$, The completeness property of $\mathbb{R}$, Archimedean property, Definition and types of intervals, Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$	**15 h**
II	**Sequences of Real Numbers:** Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, 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 first theorem on limit, Cauchy's convergence criterion. Completeness property of set of real number.	**15 h**
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, Raabe's test, Logarithmic test, Cauchy's condensation Test, De Morgan & Bertrand's test.	**20 h**
IV	**Alternating series**: Alternating series, Leibniz test, Absolute and conditional convergence. Properties of absolutely convergent series.	**10 h**

Sessional Internal Assessment (SIA) Full Marks . 25 Marks

A . Internal written Examination . 20 Marks (1 Hr)
B . Over All Performance including Regularity . 05 Marks

Books Recommended:

1. Real Analysis: Dasgupta & Prasad
2. Real Analysis: Lalji Prasad
3. Real Analysis: K.K. Jha
4. Principle of Real Analysis: S. C. Malik

Program: **Diploma** Class: **UG**	Year: **Second**	Semester: **IV**
Subject: **Mathematics**		
Course Code: **MN-2B**	Course Title: **Discrete Mathematics-II**	

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

a) Understand and explain the basic concepts of graph theory.
b) Apply the basic concepts of mathematical logic.
c) Analyze the basic concepts of mathematical logic.
d) Evaluate some real time problems using concepts of graph theory.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Logic:** Boolean algebra, Boolean expression, application to switching circuits.	15
II	**Graph Theory:** Basic Terminology, Walks, paths, circuits, connectedness, Handshaking Lemma, Isomorphism, Sub graphs, Reach ability, Union and Interaction of Graphs. Euler Graph, Shortest path problem, Hamiltonian graph, Traveling Salesman Problem, Bipartite graphs.	15
III	**Trees:** Introduction to trees, Rooted trees, path length in rooted trees, spanning trees, Fundamental circuits, spanning trees of a weighted graph, cut sets and cut vertices, Fundamental cut set, Minimum spanning tree.	15
IV	**Directed Graph:** Directed graphs and connectedness, directed trees, Matrix representation of a graph, Planar graphs: Combinational and Geometric Duals, Kuratowski's graphs, Detection of planarity, 5 colour problem.	15

Sessional Internal Assessment (SIA) Full Marks 25 Marks
A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. C.L. Liu, Elements of Discrete Mathematics, Tata McGraw Hill, 2nd Edition, 2000.
2. N. Deo, Graph Theory with Applications to Engineering and Computer Science, PHI publication, 3rd edition, 2009
3. Harikishan, Shivraj Pundir and Sandeep Kumar, Discrete Mathematics, Pragati Publication, 7th Edition, 2010.
4. Colmun, Busby and Ross, Discrete Mathematical Structure, PHI Publication, 6th Edition, 2009

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **V**
Subject: **Mathematics**		
Course Code: **MN-1C**	Course Title: **Vectors**	

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

a) Understand the concepts of scalar & vector products of three and four vectors.
b) Understand the concept of vector function of scalar variable t, Scalar point functions, vector point functions, Grad, Curl and Divergence.
c) Inter-relationship amongst the line integral, double and triple integral formulations
d) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	**Product of three & four vectors:** Product of 3 & 4 vectors, Reciprocal system of vectors, Lami's theorem, $\lambda - \mu$ theorem, work done, Moment of force. Couple.	**15 h**
II	**Vector Differentiation:** Vector function of scalar variable t, it's derivative and geometrical meaning, Derivative of product of two and three vectors	**15 h**
III	**Grad, Divergence & Curl:** Scalar point function and vector point function, grad, divergence and curl, their expansion formulae and properties.	**15 h**
IV	**Green's, Stoke's & Gauss's Divergence theorem:** Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.	**15 h**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Advanced Engineering Mathematics (10th edition). Erwin Kreyszig, Wiley
2. Vector Analysis: Lalji Prasad, Paramount

Program: **Bachelor's Degree** Class: **UG**	Year: **Third**	Semester: **VI**
Subject: **Mathematics**		
Course Code: **MN-2C**	Course Title: **Probability Theory**	

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

a) Use basic counting techniques (multiplication rule, combinations, permutations) to compute probability and odds.
b) Compute conditional probabilities directly and using Bayes' theorem, and check for independence of events.
c) Set up and work with discrete random variables. In particular, understand the Bernoulli, binomial, geometric and Poisson distributions.
d) Work with continuous random variables. In particular, know the properties of uniform, normal and exponential distributions.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	**Content**	**Hours**
I	Random experiment, Sample Space, Algebra of events, Probability of an event, mutually exclusive events, addition theorem, Conditional probability, independent events, multiplication theorem, Total probability, Baye's theorem,	**15**
II	Random Variables and Distribution Functions, Introduction, Distribution Functions of Discrete Variables, Distribution Functions of Continuous Variables, Mathematical Expectations,	**15**
III	Binomial Distribution, Poisson's Distribution, Hypergeometric distribution, Normal & Negative binomial distribution,	**15**
IV	Frequency distribution, graphical and diagrammatic representation of data. Measures of location and dispersion, moments, skewness and kurtosis. Curve fitting, association of attributes. Simple correlation and regression,	**15**

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Fundamental of Mathematical Statistics: Gupta & Kapoor
2. Probability and Statistics for Engineering and the Sciences: Jay L. Devore,

<table>
<tr><td>Program: Bachelor's Degree with Honours/Hons. with Research
Class: UG</td><td colspan="2">Year: Fourth</td><td>Semester: VII</td></tr>
<tr><td colspan="4">Subject: Mathematics</td></tr>
<tr><td colspan="2">Course Code: MN-1D</td><td colspan="2">Course Title: Real Analysis-II</td></tr>
<tr><td colspan="4">Course Learning Outcomes: This course will enable the students to:
a) Understand the concept of limit & continuity of a function.
b) Understand the concept of differentiation and expansion of function with remainder.
c) Understand the definition and condition for Riemann Integrability.
d) Understand the generalized set operations and relation on sets.</td></tr>
<tr><td colspan="2">Credit: 4 (Theory)</td><td colspan="2">Compulsory</td></tr>
<tr><td colspan="2">Full Marks: 75</td><td colspan="2">Time: 3 Hours</td></tr>
<tr><td>Unit</td><td colspan="2">Content</td><td>Hours</td></tr>
<tr><td>I</td><td colspan="2">Limit and Continuity: Limit, Continuity, Discontinuities, uniform continuity, properties of functions continuous in closed intervals, Functions of bounded variation.</td><td>20 h</td></tr>
<tr><td>II</td><td colspan="2">Derivability, Relationship with continuity, Taylor's theorem, Maclaurin's theorem, remainder after n terms, Power series expansion of $(1+x)^n, sinx, cosx$ and $log(1+x)$ using suitable remainder after n terms.</td><td>20 h</td></tr>
<tr><td>III</td><td colspan="2">Riemann Integration Definition, Darboux's theorem I & II. Integrability condition, particular classes of bounded integrable function primitive, fundamental theorem, first and second Mean value theorem.</td><td>20 h</td></tr>
<tr><td colspan="4">Sessional Internal Assessment (SIA) Full Marks . 25 Marks
A . Internal written Examination . 20 Marks (1 Hr)
B . Over All Performance including Regularity . 05 Marks</td></tr>
<tr><td colspan="4">Books Recommended:
1. Real Analysis by Lalji Prasad
2. Real Analysis by K. K. Jha
3. Principle of Real Analysis: S. C. Malik</td></tr>
</table>

Program: **Bachelor's Degree with Honours/Hons. with Research** Class: **UG**	Year: **Fourth**	Semester: **VIII**
Subject: **Mathematics**		
Course Code: **MN-2D**	Course Title: **Operations Research**	

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

a) solve problems related to linear programming problems.

b) solve problems related to transportation & assignment problems.

c) Solve real life problems using replacement model and sequencing.

Credit: **4 (Theory)**	**Compulsory**
Full Marks: **75**	Time: **3 Hours**

Unit	Content	Hours
I	Convex sets in R2 and their properties, L.P.P., problem formulation, Graphical Method. Simplex method including Big M-method,	15
II	Duality: Definition of the dual problem, Primal-dual relationships, Dual simplex Method.	15
III	Transportation and Assignment problems	15
IV	Deterministic replacement models, sequencing problems on two machines and n jobs.	15

Sessional Internal Assessment (SIA) Full Marks 25 Marks

A Internal written Examination 20 Marks (1 Hr)
B Over All Performance including Regularity 05 Marks

Books Recommended:

1. Linear Programming Problem: R.K. Gupta
2. Linear Programming Problem: Lalji Prasad
3. Operations Research: Kanti Swaroop
4. Operations Research: S. D. Sharma

Dr. Bijay Kumar Sinha   Dr. Md. Moiz Ashraf   Dr. P. C. Banerjee   Mr. Mahendra Kumar Rana