Year-2023-2024

Syllabus of B.Sc. Programme: [Subject Name: Mathematics]

In accordance with NEP-2020

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Max. Marks.	Credits
1	I	UGMM-101(N)	Differential Calculus	Theory	100	2
		UGMM-102(N)	Analytical Geometry	Theory	100	2
	II	UGMM-103(N)	Integral Calculus	Theory	100	2
		UGMM-104(N)	Differential Equation	Theory	100	2
2	III	UGMM -105(N)	Mechanics-I (Statics and Dynamics)	Theory	100	2
		UGMM -106(N)	Mechanics-II (Dynamics and Hydrodynamics)	Theory	100	2
	IV	UGMM -107(N)	Linear Algebra	Theory	100	2
		UGMM -108(N)	Calculus of function of several variable and Vector Calculus	Theory	100	2
3	V	**Discipline Centric Elective Course**				
		DCEMM -109(N)	Abstract Algebra	Theory	100	2
		DCEMM -110(N)	Number Theory	Theory	100	2
		DCEMM-111(N)(P)	Viva Voce	**Practical**	100	2
	VI	**Skill Enhancement Course**				
		SBSMM-03(N)	Elementary Analysis	Theory	100	4
		Discipline Centric Elective Course				
		DCEMM -112(N)	Advance Analysis	Theory	100	2
		DCEMM -113(N)	Function of Complex Variable	Theory	100	2
		DCEMM-114(N)(P)	Viva Voce	**Practical**	100	2
				Total Marks/Credit	**1500**	**32**

Syllabus for B.Sc. Subject: MATHEMATICS

<table>
<tr><td colspan="3">Course prerequisites: 10+2 with Mathematics</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year: 2023-24</td><td>Semester: I</td></tr>
<tr><td colspan="3">Subject: MATHEMATICS</td></tr>
<tr><td>Course Code: UGMM-101(N)</td><td colspan="2">Course Title: Differential Calculus</td></tr>
<tr><td colspan="3">Course Objectives:
➢ To understand the basics concept of set theory, function and relations with their properties.
➢ To understand the limit, continuity with their applications.
➢ To know about the differentiation and their application in solving real life problem.
➢ To determine the derivative of some special functions.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO1: The student will be able to understand about the sets, relation and function with their properties.
CO2: The student shall understand the importance and solution procedure of problems related to limit and continuity.
CO3: The student will get to know about differentiation and its applications in determining the derivatives of higher orders.
CO4: The student shall understand the importance and applications of Rolle's theorem, Lagrange's Mean value Theorem and Cauchy Mean value Theorem.</td></tr>
<tr><td colspan="2">Credits: 2</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Max. Marks: 100</td><td>Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2">Set, Relation, Function and its Property</td></tr>
<tr><td>Unit I</td><td colspan="2">Set and Relation: Set Theory, Types of sets, Operations on Sets, Laws Relating Operations, De Morgan's Laws, Venn diagram, Cartesian product of two sets, Relation, Definition and Examples Domain and Range of a Relation, Types of Relations, Composition of Relation, Equivalence relation in a set, Partition of a Set, Quotient set of a set, Oder Relation and Examples.</td></tr>
<tr><td>Unit II</td><td colspan="2">Functions: Functions or mapping, Direct and inverse images of subsets under maps, Real valued Functions of one variable, Inverse functions, Graphs of functions, Operations on functions, Composite of functions, Even and odd functions, Monotone functions, Periodic functions, Axiomatic introduction of $\mathbb{R}$ as a complete ordered field, Basic properties of R, Absolute value, Intervals on the real line.</td></tr>
<tr><td>Unit III</td><td colspan="2">Limits: Definition of limit of a function at a point of its domain, Algebra of Limits, Infinite Limits (Limits as $x \to \pm\infty$), One Sided Limits.</td></tr>
<tr><td>Unit IV</td><td colspan="2">Continuity: Continuity (Definitions and Examples), Algebra of continuous functions, Properties of continuous functions, Local Boundedness supremum and infimum of a function, Boundedness and intermediate value theorem, properties of continuous functions over closed intervals, Type of discontinuity, Image of a closed interval under continuous maps.</td></tr>
<tr><td>Block 2</td><td colspan="2">Differential Calculus</td></tr>
</table>

Unit V	**Differentiability and Derivatives:** Differentiability of a function at a point, Definition of derivative of a function and its geometrical interpretation, Derivatives of some simple functions, Algebra of derivatives, Chain rule. Sign of derivatives and monotonicity of functions, Continuity versus Differentiability. Derivative of exponential function, Logarithmic functions.
Unit VI	**Derivative of Hyperbolic Functions and Some Special Functions:** Definition of Hyperbolic Functions, Derivative of Inverse Hyperbolic Functions Methods of Differentiation (Derivative of x^r), Logarithmic Differentiation, Derivatives of functions defined in terms of a parameter, Derivatives of Implicit Functions , Derivatives of Trigonometric Functions, Derivative of the Sine Function, Derivative of the Cosine Function, The Derivatives of the other trigonometric functions, Derivative of the Tangent Function, Derivatives of Inverse Functions, Derivatives of Inverse Trigonometric Functions, Use of Transformations.
Unit VII	**Successive Differentiation:** Second and third order Derivatives, n^{th} Order Derivatives. Leibnitz's Theorem. Maclaurin's Series, Taylor's Series
Unit VIII	**Mean value theorems:** Rolle's theorem, Lagrange's Mean value Theorem and Cauchy Mean value Theorem.

Suggested Text Book Readings:

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 2020.
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc, 1991.
3. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication, 2001.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

Suggested online link:

1. https://archive.nptel.ac.in/courses/111/104/111104092
2. https://onlinecourses.nptel.ac.in/noc23_ma13/preview
3. https://archive.nptel.ac.in/courses/111/104/111104144
4. https://archive.nptel.ac.in/courses/111/105/111105122

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** I
Subject: MATHEMATICS		
Course Code: UGMM-102(N)	**Course Title:** Analytical Geometry	

Course Objectives:

- To understand the basic concepts of conic section and curve tracing.
- To develop working skills with straight line, sphere and cylinder.
- To acquire basic knowledge about cones, reciprocal, enveloping and right circular cone.
- To learn the concepts and uses of central conicoids.

Course Outcomes:

CO1: The student will get to know about conic section and curve tracing, and its applications in finding the area, surface and volumes.

CO2: The student shall understand the concepts of straight line, plane, sphere, intersection of sphere and plane, cylinder and right circular cylinder, cones and right circular cone.

CO3: The subjects learn and visualize the fundamental ideas about coordinate geometry and learn to describe some of the surface by using analytical geometry.

CO4: The student will be able to understand the central conicoids with properties and their applications.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Conic Section**
Unit I	**Conic Section:** Homogeneous equation of second degree and conditions on it to represent different types of conics. Polar coordinates Polar equation of a line, parabola, ellipse and hyperbola when focus is taken as pole. Polar equations of the chord joining two points.
Unit II	**Curve Tracing:** Tangent, normal, polar (chord of contact), pair of tangent lines, asymptotes, Tracing of a conic.
Block 2	**Sphere and Cylinder**
Unit III	**Geometry of 3-Dimension:** Straight line and plane, direction cosines and direction numbers, distance of a point from a line, various form of the equation of a plane, plane passing through three given points, angle between two lines and two planes, distance of a point from a plane, equation of line of intersection of two planes, intersection of line and plane. Coplanar lines shortest distance between two skew lines.
Unit IV	**Sphere:** Equation of a sphere, Intersection of sphere and planes, Intersection of two sphere. Sphere passing through a circle, Intersection of a straight line and a sphere. Tangent planes, Polar planes, Plane of contact. Power of a point. Radical planes, Radical lines, Co-axel system of a sphere. Orthogonal system of sphere.
Unit V	**Cylinder:** Equation of a cylinder with given base, Cylinder with Axis parallel to co-ordinate axes. Enveloping cylinders, Right circular cylinders. Rules surfaces, generating lines of a hyperboloid of one sheet and their simple properties.
Block 3	**Cones and Central Conicoids**

Unit VI	**Cones:** Equation of a cone with a given base, Intersection of a cone and a plane passing through the vertex of cone, tangent plane, reciprocal cone, Enveloping cone, right circular cone.
Unit VII	**Central Conicoids-I:** Standard equation of a Central conicoid, ellipsoid, hyperboloid of one sheet and two sheets, tangent planes, tangent lines, polar planes and polar lines.
Unit VIII	**Central Conicoids-II:** Enveloping cones and cylinders section with a given centres. Diametric plane, conjugate diameters, normal, normal drawn from a given point.

Suggested Text Book Readings:

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd. 1923.
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson, 2017.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan & Company, London, 2016.
4. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** II
Subject: MATHEMATICS		
Course Code: UGMM-103(N)	**Course Title:** Integral Calculus	

Course Objectives:

- To understand the basics concepts of integration and their methods.
- To develop working skills with integration and use of reduction formula in integration.
- To learn the integration of rational and irrational function and tangent normal to the curves.
- To discuss the applications of integration.

Course Outcomes:

CO 1: The student shall understand the Integration and their solvable techniques.

CO 2: The student will be able to understand the principles of integral and learns to solve a variety of practical problems in science and engineering.

CO3: The student will get to know about solutions of integration of rational and irrational function.

CO4: The student will get to know about integral calculus and its applications in finding areas, surface and volumes.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Integration**
Unit I	**Method of Integration:** Standard Integrals, Algebra of Integrals , Integration by Substitution, Integrals using Trigonometric formula, Trigonometric and Hyperbolic Substitution, Two properties of Definite integrals, Integration by Parts, Evaluation of $\int (a^2 - x^2)\, dx$, $\int (a^2 + x^2)\, dx$, $\int (x^2 - a^2)\, dx$, $\int e^{ax}$, $[f(x) + f'(x)]\, dx$.
Unit II	**Reeducation Formula:** Reduction formula, Integrals Involving trigonometric functions, Integrals involving products of trigonometric functions, Integrals Involving Hyperbolic Functions.
Unit III	**Integration of Rational and Irrational Function:** Integration of Rational and Irrational Functions Integration of Rational Function, Some simple Rational Function, Partial Fraction Decomposition, Method of Substitution, Integration of Rational Trigonometric Functions, Integration of Irrational Functions.
Unit IV	**Tangent Normal of the Curves:** Equations of tangents and normal, Angles of intersection of two curves, Tangents at the origin.
Block 2	**Application of Integral Calculus**
Unit V	**Tracing of curves:** Classifying singular points, Asymptotes (Parallel to the axes and oblique asymptotes. Tracing of curves.
Unit VI	**Area Under a Curve:** Area of the curve in Cartesian form, Polar form, Area Bounded by a closed curve**,** Length of a Plane Curve in Cartesian Form, Parametric Form, Polar form.

Unit VII	**Volume of a solid of Revolution:** Volume of a solid of Revolution in Parametric Form, Polar form, Area of Surface of Revolution in Cartesian Form, Parametric Form and Polar form.

Suggested Text Book Readings:

1. P. K. Mittal, Integral Calculus, S. Chand Limited, 2005.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
3. Piskunov, N., Differential and Integral Calculus, Vol 1 & 2, 2nd edition. Mir Publishers, 1974.
4. Kreyszig, E., Advanced Engineering Mathematics, 10th edition. John Wiley & Sons, 2010.
5. Malik, A.K., Mathur, P, Purohit, S.D., A text Book of Engineering Mathematics-I, Manakin Press, 2020.

Suggested online link:

1. https://archive.nptel.ac.in/courses/111/105/111105122

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** II
Subject: MATHEMATICS		
Course Code: UGMM-104(N)	**Course Title:** Differential Equation	

Course Objectives:

- To learn the first order ordinary differential equations with first degree and not of first degree.
- To understand the applications of differential equations.
- To acquire basic application problems described by second order linear differential equations.
- To learn the solution of ordinary differential equations of higher orders.

Course Outcomes:

CO1: The student shall understand the importance and solution procedure of solving the first order ordinary differential equations with first degree and not of first degree**.**

CO2: After completing this course, a student will be able to solve differential equations and applications in science and engineering.

CO3: The student shall understand the second order linear differential equations with constant coefficient. Furthermore, the student will be able to develop understanding towards Euler-Cauchy linear equations and Simultaneous linear differential equations.

CO4: To understand and able to solve the various differential equation with variable coefficients used in engineering and science.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Differential Equations of First Order and First Degree**
Unit I	**Differential equation:** Differential equations, Types of differential equations, Order and degree of differential equations, Formation of differential equation, Solution of differential equation, Geometrical meaning of a differential equation, Initial value problems and statement of Existence and Uniqueness Theorems.
Unit II	**Methods of solution of a differential equation of first order and first degree:** Methods of solution of a differential equation of first order and first degree, Method of separation of variables. Solution of homogeneous equations. Equation reducible to homogeneous form.
Unit III	**Linear differential equation**: Linear differential equation and Bernoulli's linear differential equation.
Unit IV	**Exact differential equations**: Exact differential equations. Integrating factors to solve non-exact differential equations in different cases.
Unit V	**Differential equation of the first order but not of the first degree**: Differential equation of the first order but not of the first degree, Equation solvable for x, y and p. Clairaut's equation and singular solutions.
Block-2	**Applications of differential equation**
Unit VI	**Geometrical Applications of Differential Equations**: Applications of differential equation, geometrical application and physical applications; Newton's law of cooling,

	Kirchoff's law of electric circuits, motion under Gravity, rectilinear motion, simple harmonic motion, rate of growth or decay, heat flow.
Unit VII	**Physical applications of differential equations of first order and first degree-I:** The n^{th} order linear differential equation with constant coefficients, general solution and particular integrals. Method of finding particular integrals Methods of undetermined coefficient, variation of parameters.
Unit VIII	**Physical applications of differential equations of first order and first degree-II**: Physical applications of differential equations of first order and first degree-II, Method of finding particular integrals by inverse operator methods.
Block-3	**The nth order linear differential equation with constant coefficients**
Unit IX	**The nth order linear differential equation with constant coefficients:** Method of finding particular integrals by inverse operator methods.
Unit X	**Methods of finding particular integrals by inverse operator method:** Linear differential equations of second order. Transformation of the equation by changing the dependent variable, independent variables and Normal forms.
Unit XI	**Linear Equations with constant coefficients:** Equation reducible to Linear with constant coefficients, Euler-Cauchy linear equations. Simultaneous linear differential equation with constant coefficient.
Unit XII	**Linear differential equations:** Linear differential equations of second order. Transformation of the equation by changing the dependent variable, independent variables and Normal forms.

Suggested Text Book Readings:

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGraw-Hill.
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa Publication.
3. M., D. Rai Singhania, Ordinary Differential Equation, S. Chand, 2020.
4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.
5. Malik, A.K., Mathur, P & Purohit, S.D., A text Book of Engineering Mathematics-II, Manakin Press, 2019.

Suggested online link:

1. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==**
2. **https://archive.nptel.ac.in/noc/courses/111**

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer:

Differential equations for engineers By Prof. Srinivas Rao Manam
https://onlinecourses.nptel.ac.in/noc22_ma72/preview

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** III
Subject: MATHEMATICS		
Course Code: UGMM-105(N)	**Course Title:** Mechanics-I (Statics and Dynamics)	

Course Objectives:

- To learn the stable and unstable equilibrium in statics.
- To develop competency in understanding of virtual work and common catenary.
- To understand the motion in a plane, tangential and normal directions, rectilinear motion.
- To understanding the constrained motion and motion under central forces.

Course Outcomes:

CO1: The student shall understand the basic concepts of Statics.

CO2: The student will get to know about virtual work, displacement, tensions and string.

CO3: The student shall understand the dynamics system and describe the theoretical workings of the rectilinear motion, simple harmonic motion and their utility in real life.

CO4: The student shall understand the importance and solution procedure of constrained motion and motion under central forces.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Statics**
Unit I	**Stable and Unstable equilibrium:** Stable and Unstable equilibrium definition and examples, Stability, Condition of Stability, Heavy body on a fixed body.
Unit II	**Virtual work:** Virtual works and displacement, Principal of Virtual work acting on a particle, Principal of Virtual work of rigid body, tensions, string.
Unit III	**Common Catenary:** Definition of Common Catenary, intrinsic equation, Cartesian equation, definitions to Catenary, Relation for Common Catenary, Stretched wires.
Block 2	**Dynamics**
Unit IV	**Motion in a Plane:** Motion in a plane, Velocities and accelerations in Cartesian coordinates, along radial and transverse directions, and along tangential and normal directions. Determination of path under a given force.
Unit V	**Rectilinear Motion:** Rectilinear Motion, Simple harmonic motion. Elastic strings. Motion under inverse square law and other miscellaneous laws, Motion in resisting medium. Motion of particles of varying mass, Rocket motion.
Unit VI	**Constrained Motion:** Constrained motion (Vertical circle and vertical cycloid).
Unit VII	**Motion under Central Forces:** Motion under Central forces: Central orbit, Conservation of angular momentum, areal velocity, Kepler's laws of motion, and differential equations to the path of a particle.

Suggested Text Book Readings:

1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentice Hall Publishers.
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentice Hall Publishers.
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill.
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill.

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** III
Subject: MATHEMATICS		
Course Code: UGMM-106(N)	**Course Title:** Mechanics-II (Dynamics and Hydrodynamics)	

Course Objectives:

- To learn about moment of inertia and D'Alembert's principle.
- To learn the motion about a fixed axis, equation of motion about axis of rotation.
- To understand the boundary surfaces, Euler's equation of motion and impulsive motion.
- To understanding the doublets, image system of a doublet with respect to a plane, a circle, a sphere.

Course Outcomes:

CO1: The student shall understand the basic concepts and application of moment of inertia and D'Alembert's principle.

CO2: The student will get to know about motion about a fixed axis, equation of motion about axis of rotation.

CO3: The student shall understand the hydrodynamics system and describe the boundary surfaces, Euler's equation of motion and impulsive motion, and their utility in real life.

CO4: The student shall understand the importance of doublets, image system of a doublet with respect to a plane, a circle, a sphere.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Dynamics**
Unit I	**Moment of Inertia:** Moment and product of inertia of some standard bodies, principle axis, Momental ellipsoid of a body.
Unit II	**D' Alembert Principle**: The general equation of motion, motion of the centre of inertia and motion relative to the centre of inertia.
Unit III	**Motion about a fixed axis**: Moment of the effective forces about the axis of rotation, moment of momentum about the axis of rotation, kinetic energy of the body rotating about a fixed axis, equation of motion about axis of rotation.
Block 2	**Hydrodynamics**
Unit IV	**Boundary surfaces:** Equation of continuity in different coordinate system and boundary surfaces, velocity potential, stream-lines.
Unit V	**Euler's equation of motion:** Euler's equation of motion, steady motion, Bernoulli's equation, Helmholtz equation, Impulsive motion.
Unit VI	**Motion:** Motion in two dimensions, stream function, irrotational motion, complex potential, sources and sinks.
Unit VII	**Doublet:** Doublets, image system of a simple source with respect a plane, a circle, a sphere. Image system of a doublet with respect to a plane, a circle and a sphere, circle theorem.

Suggested Text Book Readings:

1. Nag, P.K., Engineering Thermodynamics, 3rd ed., Tata McGraw-Hill, 2005.

2. Robert Norton., “Kinematics and Dynamics of machinery” 1st Ed., McGraw Hill India., 2009.
3. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentice Hall Publishers.
4. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill.
5. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill.

Suggested online link:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year: 2023-24**	**Semester:** IV
Subject: MATHEMATICS		
Course Code: UGMM-107(N)	**Course Title:** Linear Algebra	

Course Objectives:

- To understand the vector space, field and their properties.
- To learn about the basis and dimension of a vector space and quotient spaces.
- To understand the matrices, linear system of equations, Eigen values and Eigen vectors.
- To find the characteristic polynomial, inner product space, bilinear and quadratic forms.

Course Outcomes:

CO1: The student will be able to understand the basic concepts and uses of vector space field and their properties.

CO2: The student will get to know about basis and dimension of a vector space and quotient spaces.

CO3: The student will be able to understand the basic concepts and uses of matrices for solving system the linear system of equations, eigen values and eigen vectors with its importance.

CO4: The student shall understand the characteristic polynomial, inner product space, bilinear and quadratic forms with their applications.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Vector Space**
Unit I	**Introduction to Vector Spaces:** Binary operations, Field, Examples $\mathbb{Q}, \mathbb{R}, \mathbb{C}$, $\mathbb{Z}_p$ $(p, a$ prime) of fields. Definition of a vector space, Some basic properties of a vector space, Vector subspace, Subspace spanned by subsets with examples. Linearly dependence and independence of a subset. Finite dimensional vector spaces.
Unit II	**Basis, Dimension and Quotient Spaces**: Basis of a vector space, Dimension of a vector space, finite dimensional vector space, linear sum and direct sum of subspaces, Quotient spaces.
Unit III	**Linear transformations**: Definition examples and some properties, Linear transformations and Isomorphism of vector spaces, Null space and range space. Rank and Nullity of linear transformations, Fundamental theorem of vector space homomorphism, Rank-Nullity theorem, Non-singular, Invertible transformations.
Unit IV	**Dual Vector Space:** Hom (V, W) as a vector space, dual space $\mathbf{V}^*$ of a vector space **V**, Dual basis of a vector space with examples, Transpose of a linear transformations. Annihilator of a subset of a vector space, Rank of transpose of a linear transformation.
Block 2	**Matrix**
Unit V	**Matrices:** Matrix representation of linear transformations, equality, Algebra of matrices, Multiplication of matrices. Vector space of all m × n matrices over a field. Ring of all n-square matrices. Invertible matrices (or Non-singular matrix), Transpose of matrix, Equivalent matrices, Similar Matrices, and Orthogonal matrices.
Unit VI	**Rank of a matrix:** Rank of a matrix, Row rank and column rank of a matrix, Elementary matrices, elementary row and column operations of a matrix, elementary matrices,

	Normal form of a matrix, Echelon form of matrix, Inverse of a non-singular matrix. Determinant rank of a matrix. Non-homogeneous and homogeneous linear equations.
Unit VII	**Determinants:** Determinant of a square matrix, Cofactor of an element of a determinant, Properties of a determinant, minor of an element of a determinant, Evaluation of a determinant. Laplace expansion of a determinant. Product of two determinants (all statements without proof).
Unit VIII	**Eigen Vector and Eigen Space:** Adjoint of n- square matrix. Inverse of a matrix of a non-singular matrix by using adjoint of the matrix. Characteristic roots or Eigen values of a linear transformation and Eigen vector and Eigen space.
Block 3	**Characteristic polynomial inner product space bilinear quadratic forms**
Unit IX	**Characteristic polynomial of a matrix:** Characteristic polynomial of a matrix, Diagonalization of a matrix, Caley - Hamilton theorem. Inverse of a matrix of a non-singular matrix by Caley – Hamilton theorem. Characteristic polynomial of a linear transformation, Minimal polynomial, Hermitian Matrix, characteristic roots of a complex Hermitian matrix.
Unit X	**Inner product space**: Definition and examples of inner product, length of a vector, Cauchy Schwarz inequality, distance between two vectors, angle between two vectors, Orthogonal and ortho normal sets.
Unit XI	**Bilinear, quadratic and Hermitian forms**: Bilinear, quadratic and Hermitian forms, bilinear form on a vector space **V**. Quadratic forms, matrix of quadratic form, normal form or canonical form.

Suggested Text Book Readings:

1. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
2. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
3. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
4. Malik, A.K., Mathur, P, Purohit, S.D., A text Book of Engineering Mathematics-II, Manakin Press, 2019.

Suggested online link:

1. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==**
2. **https://archive.nptel.ac.in/courses/111/104/111104125**
3. **https://onlinecourses.nptel.ac.in/noc23_ma07/preview**

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** IV
Subject: MATHEMATICS		
Course Code: UGMM-108(N)	**Course Title:** Calculus of Function of Several Variables and Vector Calculus	

Course Objectives:

- To learn about the partial differentiation and jacobians with their applications.
- To understand the maxima and minima, and Lagrange's method of undetermined multipliers with their importance.
- To understand the basic concepts and uses of vector calculus.
- To know about applications of vector calculus.

Course Outcomes:

CO1: The student shall understand the partial differentiation, Euler's Theorem on Homogeneous functions.

CO2 The student will get to know about the maxima and minima of function s of two variables, Lagrange's method of undetermined multipliers.

CO3: The student will get to know about the basic concepts and uses of vector calculus.

CO4: The student shall understand the importance and applications of vector calculus like as curl, gradient and divergence.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Partial Differentiation**
Unit I	**Partial Differentiation:-**Partial Derivatives of first order, Partial Derivatives of Higher order, Total derivative, Homogeneous functions, Euler's Theorem on Homogeneous functions, Deductions from Euler's Theorem.
Unit II	**Composite Functions**:- Differentiation of Composite Functions, Jacobians, Properties of Jacobians, Theorems on Jacobians, Jacobian of Implicit Functions, Functional Relationship,
Unit III	**Maxima and minima:-** Maxima and minima of functions of Two variables, Conditions for maxima and minima, Necessary condition for existence of maxima and minima, Local and global maxima and minima of a function, Lagrange's method of undetermined multipliers.
Block 2	**Vector Calculus**
Unit IV	**Operations on Vectors:-** Scalar triple product and its geometrical interpretation. Properties of scalar triple product. Reciprocal system of vectors. Properties of the reciprocal system of vectors. Scalar product of four vectors. Vector product of four vectors**.**
Unit V	**Differentiation of a Vector Functions and Gradient:-** Scalar and vector point function. Differentiation of a vector functions with respect to scalar. Gradient of a scalar field, geometrical interpretation of gradient, directional derivative, properties of gradient, gradient in polar coordinates.

Unit VI	**Divergence and Curl:-** Divergence of a vector point function, Physical interpretation of divergence, Solenoidal vector. Curl of vector point function, Physical interpretation of curl, Irrotational vector, Vector identities, Velocity potential, Laplace operator.
Unit VII	**Integration of a Vector Function:-** Line Integral, Surface Integral, Volume Integral.
Unit VIII	**Applications:** Green's Theorem in a plane, Gauss Divergence Theorem and Stokes's Theorem (Without proof) and their applications.

Suggested Text Book Readings:

1. Kreyszig, E., Advanced Engineering Mathematics, 10th edition. John Wiley & Sons, 2010.
2. Malik, A.K., Mathur, P, Purohit, S.D., A text Book of Engineering Mathematics-1, Manakin Press, 2020.
3. Mujumdar, N. S., Function of Several Variables and Vector Calculus, Nirali publication.

Suggested online link:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==
2. https://archive.nptel.ac.in/courses/111/105/111105122
3. https://archive.nptel.ac.in/courses/111/104/111104125

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: https://onlinecourses.nptel.ac.in/noc23_ma27/preview **Integral and Vector Calculus** By Prof. Hari Shankar Mahato, IIT Kharagpur.

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** V
Subject: MATHEMATICS		
Course Code: DCEMM -109 (N)	**Course Title:** ABSTRACT ALGEBRA	

Course Objectives:

- To understand the concepts of group theory with their properties.
- To learn about the homomorphism, subgroups and cyclic group.
- To understand the normal subgroups and symmetric groups.
- To learn about the ring, field and ideal with their properties.

CO1: The student will be able to understand the basic concepts and uses of group with their properties.

CO2: The student shall understand the importance of homomorphism subgroups and uses of cyclic group.

CO3: The student will get to know about the normal subgroups and symmetric groups.

CO4: The student shall understand the applications of ring, field and ideals.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Groups and Subgroups**
Unit I	**Elementary Group Theory:** Definition of a group, abelian groups examples including $\mathbf{Z_m}$, $\mathbf{Z_p}$, $\mathbf{U_m}$ the group of n^{th} roots of unity, Hamiltonian group, Klein's four group, Permutation group, Integral power of an element of a group, order of an element of a group.
Unit II	**Homomorphism, Subgroups and Cyclic Groups:** Subgroups of a group and examples. Homomorphism, isomorphism, Subgroup generated by a subset of a group. Cyclic groups.
Unit III	**Coset Decomposition of a Group:** Coset decomposition, left coset and right coset of a subgroup of a group. Lagrange theorem. Index of a subgroup. Euler's theorem. Fermat's theorem.
Block 2	**Normal Subgroups and Symmetric Groups**
Unit IV	**Normal Subgroups and Homomorphisms:** Normal subgroups, Centre of a group. Conjugate elements, Normaliser of an element of a group. Kernel of a homomorphism. Direct and inverse image of a subgroup and a normal subgroup under a homomorphism. Quotient groups.
Unit V	**Symmetric Groups and Automorphisms:** Fundamental theorem of homomorphism of groups, Symmetric group S_n, Cayley's theorem, Cycle's transposition, Decomposition of a permutation, alternating groups A_n. Automorphisms of groups. Inner automorphisms.
Block 3	**Rings and Fields:**
Unit VI	**Rings and Fields:** Ring Definition and examples, elementary property of a ring, zero divisor, Ring with or without zero divisor. Integral domain. Division ring. Field. Homomorphism and isomorphism of Rings, subrings, subfield with examples. Kernel

	of a homomorphism.
Unit VII	**Homomorphisms and Embedding of rings:** Direct image and inverse image of a subring and a subfield under a homomorphism. Characteristic of a non-zero integral domain. Imbedding of a ring into another ring the field of fractions of an integral domain.
Unit VIII	**Ideals:** Ideals, left ideal and right ideal, principal ideal with example. Prime ideal, maximal ideal, Quotient rings. Fundamental theorem of homomorphism, rings, and field.

Suggested Text Book Readings:

1. J.B. Fraleigh, Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing House.
2. I.N. Herstein ,Topics in Algebra, Wiley, 2006.
3. Vijay K Khanna & S K Bhambri, Vijay K Khanna (Author), S K Bhambri, Vikash Publishing, 2017.
4. Frank Ayres & Lloyd R. Jaisingh, Schaum's Outline of Abstract Algebra, McGraw hill, 2020.

Suggested online link:

1. https://archive.nptel.ac.in/courses/111106137

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** V
Subject: MATHEMATICS		
Course Code: DCEMM -110 (N)	**Course Title:** Number Theory	

Course Objectives:

- To understand the basics concept of number theory.
- To learn about the Chinese Remainder Theorem and Euler's function.
- To understand the Gauss theorem, Gauss reciprocity theorem and Quadratic residues for prime-power moduli.
- To know about the arithmetic function with their applications in solving real life problem.

Course Outcomes:

CO1: The student will be able to understand about the basics concept of number theory.

CO2: The student shall understand the importance and applications of the Chinese Remainder Theorem and Euler's function.

CO3: The student will get to know about Gauss theorem, Gauss reciprocity theorem and Quadratic residues for prime-power moduli.

CO4: The student shall understand the importance and applications of arithmetic function.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Basic Introduction of Number Theory**
Unit I	**Analytic Number Theory**: Division algorithm, Euclid's algorithm for the greatest common divisor, Prime numbers, fundamental theorem of arithmetic.
Unit II	**Congruence's:** Linear congruences and algorithm to find the solution of Linear congruences, Chinese Remainder Theorem, An extension of Chinese Remainder Theorem (with non-coprime moduli).
Unit III	**Euler's Function and application:** Definition of Euler function, examples and properties, Multiplicative property of Euler's function.
Block 2	**Gauss theorem & Applications**
Unit IV	**Quadratic residues of Number Theory:** The group of units modulo an integer, primitive roots, Existence of primitive roots, Quadratic congruences, Quadratic residues, Legendre symbol, Euler's criterion.
Unit V	**Gauss theorem**: Gauss lemma, Gauss reciprocity theorem, Quadratic residues for prime-power moduli and arbitrary moduli.
Unit VI	**Arithmetic Functions and applications:** Arithmetic Functions**,** multiplicative functions and their properties, Mobius function and its properties, Mobius inversion formula and its applications.

Suggested Text Book Readings:

1. Niven, I., Zuckerman, H. S. and Montegomery, H. L. (2003) An Int. to the Theory of Numbers (6th edition) John Wiley and sons, Inc., New York.

2. Burton, D. M. (2002) Elementary Number Theory (4^{th} edition) Universal Book Stall, New Delhi.

3. Balakrishnan, V. K. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including

Concepts of Graph Theory, Schaum's Outline. **Suggested online link:** 1. **https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==**
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** V
Subject: MATHEMATICS		
Course Code: SBSMM -03(N)	**Course Title:** Elementary Analysis	

Course Objectives:

- To understand the logical connectives, tautology and quantifiers.
- To learn about relation, equivalence relation and mapping with their properties.
- To understand the real number system and division in Integers, sequences and infinite series.
- To know about the multiple integral and their applications in areas and volume.

Course Outcomes:

CO1: The student will get to know about the concepts of logical connectives, tautology and quantifiers.

CO2: The student shall understand the relations and its types, equivalence relations and mapping.

CO3: The student shall understand the real number system and division in Integers, sequences and infinite series.

CO4: The student will get to know about multiple integral and its applications in finding areas, surface and volumes.

Credits: 4	**Type of Course:** Core
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Language of Mathematics, Relation and Mapping**
Unit I	**Language of Mathematics:** Language of Mathematics, Mathematical statements, logical connectives, Tautology, quantifiers.
Unit II	**Relation:** Relations (definition and examples), types of relation, composite of relations, equivalence relation, equivalence class, partition of a set and order relation.
Unit III	**Mapping:** Mapping (definition and examples), types of map, inverse map, composition of maps, direct and Inverse images of a set.
Block 2	**Real number system and Division in Integers**
Unit IV	**Real number system:** Axiomatic definition of real number system as a complete ordered field. Archimedean principle, relational and irrational density theorem.
Unit V	**Division in Integers:** Division in Z, Division algorithm, greatest common divisor, and least common multiple. Euclidean algorithm. Prime integers. Fundamental theorem of arithmetic's.
Block 3	**Sequence and Infinite Series**
Unit VI	**Sequence of Real Number:** Sequences, bounded and unbounded sequences, Subsequence, convergent, divergent and oscillatory sequences. Limit of a sequence. Algebra of convergent sequences, Cauchy's sequences, and Cauchy's criterion for convergence of a sequence.
Unit VII	**Infinite Series**: Partial sums of a series. Convergence and divergence of series. Series of nonnegative terms. Necessary and sufficient condition for convergence. P-series theorem. Comparison tests. D'Alembert's ratio test, Raabe's ratio test, Logarithmic test, Cauchy's condenses test and Root test, Alternating series.

	Leibnitz's theorem. Absolute convergence and conditional convergence of a series.
Block 4	**Multiple Integral and Its Applications**
Unit VIII	Double and Triple integrals, Change of order of integration, surface and volume integration and their applications in areas and volume.

Suggested Text Book Readings:

1. Elementary Analysis: The Theory of Calculus by Kenneth. A. Ross.
2. Sharma and Vashishtha, Real Analysis, Krishna Publication, 2014.
3. S C Malik, Mathematical Analysis, New Age International Publishers, 2017.

Suggested online link:

1. https://archive.nptel.ac.in/courses/111/105/111105122

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** VI
Subject: MATHEMATICS		
Course Code: DCEMM -112 (N)	**Course Title:** Advance Analysis	

Course Objectives:

- To understand the basics concept of metric space.
- To learn about the convergence of function of series and improper integral.
- To understand the convergence test, μ-test, Abel's test, Dirichlet's test.
- To know about step function, mean value theorem for integrals and Change of variables.

Course Outcomes:

CO1: The student will be able to understand the basic concepts and uses of metric spaces with their properties.

CO2: The student shall understand the importance of convergence of function of series and uses of improper integral.

CO3: The student will get to know about the convergence, μ, Abel's and Dirichlet's test.

CO4: The student shall understand the applications of step function, mean value theorem for integrals and Change of variables.

Credits: 2	**Type of Course:** Core
Category of Course	OER
Max. Marks: 100	**Min. Passing Marks:** 36

Block 1	**Metric space, Continuity, Compactness and completeness**
Unit I	**Metric Space:** Metric space (definitions and examples), open and closed balls, interior points, exterior point, and boundary points, limit points. open and closed sets, limit of a sequence in a metric space. Cauchy sequence.
Unit II	**Limit and Continuity of Functions:** Limit and continuity of a function between metric spaces. Characterization of continuity in terms of open sets, Closed set and closer of a set.
Unit III	**Compactness:** Compactness of metric space, Bolzano Weierstrass property, Total boundedness, sequentially compact metric spaces and countable compact metric space
Block 2	**Convergence of function of series and Improper Integral**
Unit IV	**Complete Metric Space:** Uniform continuity, Lebesgue number, Complete metric space.
Unit V	**Convergence of sequence and series of functions:** Point wise and uniform convergence of a sequence and series of a functions, necessary and sufficient condition for a uniform convergence, Weierstrass test, Abels test and Dirichlet's test for uniform convergence, Term by term integration and term by term differentiation.
Unit VI	**Improper Integrals:** Convergence of improper integrals; Integral over infinite interval with bounded integrands and intervals over finite intervals with unbounded integrals. Necessary and sufficient conditions for such integrals.
Block 3	**Convergence test, Riemann integral**

Unit VII	**Convergence Test:** Comparison test, μ-test, absolute convergence, convergence of integrals of product of two functions, Abel's test, Dirichlet's test.
Unit VIII	**Step Functions:** Step function and their integrals, upper and lower integrals of a bounded function of one variable (through step functions). Integrable functions, Riemannian condition of integrability. Properties of Integrals of a step functions.
Unit IX	**Mean Value Theorem:** Mean value theorem for integrals, Fundamental theorem of integral calculus. Primitive of a function. Change of variables, second mean value theorem (statements only).

Suggested Text Book Readings:

1. S. Arumugam and A. Thangapandi Issac, Sequences and Series, Edition 2012, New Gamma Publishing House.

2. K. Chandra Sekhara Rao and K. S. Narayanan, Real Analysis Volume – I, Edition 2008, S. Viswanadhan Printers and Publishing Pvt. Ltd.

3. M. K. Venkatraman and Manorama Sridhar, Sequence and Series, Edition 2002, The National Publishing Company.

4. Singh, S. R. & Malik, A. K. Topology, I.K. International Publishing House Pvt. Limited, 2012.

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: 10+2 with Mathematics		
Programme: B.Sc.	**Year:** 2023-24	**Semester:** VI
Subject: MATHEMATICS		
Course Code: DCEMM -113 (N)	**Course Title:** Function of Complex Variables	

Course Objectives:

- To understand the basic concepts of analytic function and Cauchy Riemann equations.
- To develop working skills with complex integration, series and singularities.
- To acquire basic knowledge about calculus of residues and Evaluation of real definite integrals by contour integration.
- To learn the concepts and uses of conformal mapping and Mobius (bilinear) transformation.

Course Outcomes:

CO1: The student will get to know about analytic functions and Cauchy Riemann equations.
CO2: The student shall understand the concept of complex integration, series and singularities.
CO3: The student shall understand the importance and solution procedure of problems related to calculus of residues and Evaluation of real definite integrals by contour integration.
CO4: The student will be able to understand the basic concepts and uses of conformal mapping and Mobius (bilinear) transformation with their applications.

Credits: 2	**Type of Course:** Core
Category of Course	OER
Max. Marks: 100	**Min. Passing Marks:** 36

Syllabi framed block wise/unit wise

Block 1	**Complex variables and Power series**
Unit I	**Function of Complex Variable:** The concept of a function of a complex variable, Continuous functions, uniform continuity, bounded functions, differentiable and analytic functions, differentiability, analytic or regular functions Cauchy Riemann equations, necessary and sufficient condition for a function to be analytic, construction of analytic function, Milne Thomson method.
Unit II	**Power Series:** The circle of convergence of a power series, power series and analytic functions, the exponential functions, the trigonometric functions, the logarithmic functions.
Block 2	**Complex Integration and Expansion of series**
Unit III	**Complex Integration:** Jordan Arcs, Rectifiable arcs, contours, Complex integration, integration along a regular Arc, Cauchy theorem, the elementary form of Cauchy theorem, the general form of Cauchy theorem, extension of Cauchy's theorem on contours, defining multiply connected regions, Cauchy integral formula, derivative of an analytic function, Morera's Theorem.
Unit IV	**Expansion in series and singularities:** Taylor series, Cauchy's inequalities, Liouville's theorem, Laurent's series, isolated singularities of an analytic function, the zeros of analytic function, the behaviour of analytic function at isolated singularities, limiting point of zeros or poles, the behaviour of an analytic function near an isolated essential singularity.

Block 3	**The Calculus of Residues (Integration) and Evaluation of real definite integrals by contour integration**
Unit V	**The calculus of Residues:** The Residue at a singularity, Residue at infinity, calculation of reduced in some special cases, Cauchy's theorem of Residues, poles and zeros of a Meromorphic function. Rouche's theorem, applications of Rouche's theorem,
Unit VI	**Evaluation of Definite Integrals by Contour Integration:** Jensen's Theorem, Poisson's integral formula, The evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$, The evaluation of integrals of the type $\int_{-\infty}^{\infty} f(x)dx$.
Block 4	**Conformal Representation**
Unit VII	**Conformal Representation:** Mappings by analytic functions, Differentiable arc through a point, conformal mapping, existence of the inverse function, Conformal character and analyticity, mapping by simple functions, super facial magnification, The linear transformation, The Mobius (bilinear) transformation, The transformation $\omega = \frac{1}{z}$, Geometrical inversion, fixed points of a bilinear transformation.

Suggested Text Book Readings:

1. Ponnusamy, Foundations of Complex Analysis. 2nd Edition, Narosa Book Publication, 2008.
2. K.P. Gupta, Functions of complex variable, Sixteen Edition, Pragati Prakashan, 2002.
3. J. B. Conway, Functions of One Complex Variable, Narosa Publishing House, New Delhi, 2002.
4. Dennis G. Zill, Complex Analysis, Jones and Bartlett Publishers, 3ed
5. V. Ahlfors, Complex Analysis (Third Edition), McGraw-Hill, 1979.
6. M. Spiegel, J. Schiller, S. Lipschutz, Schaum's Outline of Complex Variables, 2ed (Schaum's Outlines)
7. James W. Brown & R. V. Churchill: Complex variables and applications, McGraw-Hill, 2006.

Suggested online link:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A==

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer:

https://archive.nptel.ac.in/courses/111/103/111103070/ by Prof. P. A. S. Sree Krishna IIT Guwahati